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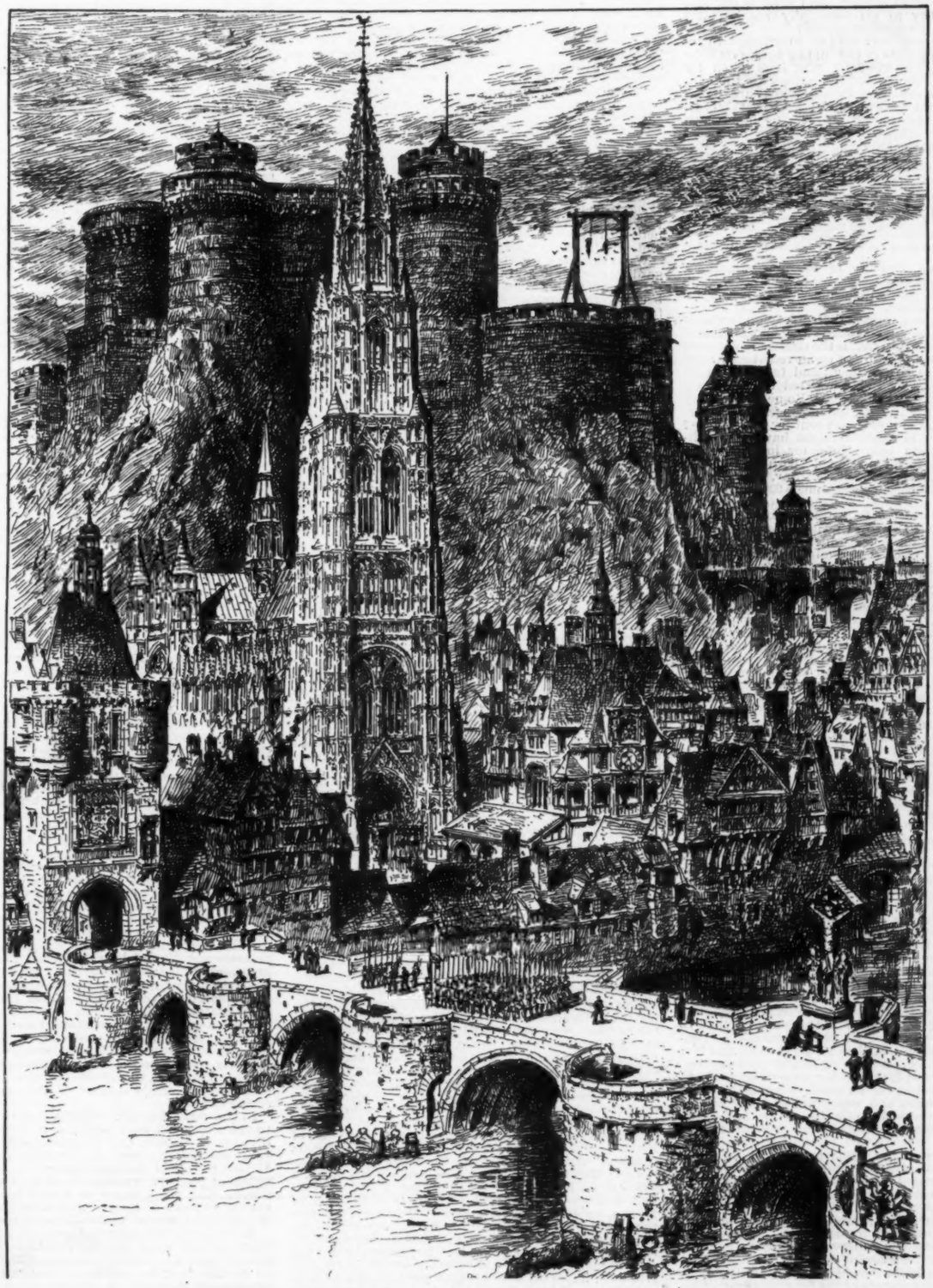


LIGHTS AND SHADOWS OF A BYGONE DAY.—Drawn by Mr. H. W. Brewer.

LIGHTS AND SHADOWS OF A BYGONE DAY.

WE have to thank the careful historical writers and students of our own day for having, by their patient research and indefatigable investigations, enabled us to understand, to a great extent, that most interesting period of the world's history known as the "Middle Ages." We now know that to speak of these times as the "Dark Ages" is absurd, because, as Dr. Wace says, "the men of the middle ages were great architects—architects in thought, in society, in politics, in ecclesiastical organization, no less than in stone and marble. In every department of human life they laid deep foundations. And they reared mighty structures, under which to this hour our religion is sheltered, our learning fostered, our social life controlled, and to which even the framework of our political institutions is in a great measure due."

Yet, on the other hand, few people accept unquestioned Digby's enthusiastic, but certainly charming, picture of the middle ages presented in the pages of "Mores Catholici," because of the undoubted cruelty, intolerance, and blind partisanship of the period, which are revolting to our ideas. Yet was it not the remarkable contrasts presented by these times that make them so interesting to study? And does it not add that special quality to art (especially architecture) which is, perhaps, its greatest charm?

It is, perhaps, beside our subject to attempt to inquire whether the people in the middle ages were happier than they are now. As a rule, it is taken for granted that those people and those times are the happiest that have no history, and consequently are spared great contrasts and violent excitement. Yet Wordsworth, the most philosophic poet of the nineteenth century, certainly thinks otherwise, as in his poem "St. Bees" we find the following passage:

> If life were slumber on a bed of down,
> Toil unimposed, vicissitude unknown,
> Sad were our lot. No hunter of the hare
> Exults like him whose javelin from the lair
> Has roused the lion; no one plucks the rose
> Whose proffered beauty in safe shelter blows
> 'Mid a trim garden's summer luxuries,
> With joy like his who climbs on hands and knees,
> For some rare plant, yon headland of St. Bees.

We refer to this diversity of opinion because, if Wordsworth is right, it accounts for much of the charm of the middle ages, which the usual view of the subject would naturally exclude.

There is, of course, one great difficulty in understanding this period which must at once strike all thoughtful readers and students, and that is the strange remoteness of the middle ages. We do not mean remoteness as to actual date, but as to sentiment and feeling, and on this ground it may be safely asserted that they are more distant from us than Greece, Rome, or possibly even ancient Egypt? What, for instance, can be further removed from the nineteenth century than Dante? Yet some passages in Aristotle might have been written the week before last. Note, for instance, that which refers to the condemnation of "cornering." The fact is, absolute dates help us little. Say, for instance, that the fourteenth century was some 5,000 years back, and the twelfth century was the "infancy of the world." Although it is incorrect as to fact, it is more in accordance with true ideas, just as the map of the world in the "Nuremberg Chronicle," which shows Europe as about three-quarters of this hemisphere, gives one a far better idea of the views entertained at that time (1493) than would the most correct geographical chart.

In studying the middle ages and their people we find a youthfulness among them that is very remarkable. The men must have been grown-up schoolboys, retaining the ardor, generosity and intense partisanship of the boy, together with his thoughtless cruelty and complete indifference to the feelings of others; ready to "go through fire and water" for his friends, but unmerciful in his views regarding boys of an opposition school; firmly convinced of the absolute correctness of his own views and the rectitude of his own principles. Now, such a creature as this, suddenly raised to man's estate, would give us an idea of the mediæval citizen. His generosity, self-sacrifice, intense devotion to his cause, determination to punish what he considered wrong regardless of all consequences, unmerciful treatment of all he thought to be wrong-doers, and thorough want of all consideration in their regard, would be his most marked features; his laws would be "a terror to the guilty;" his enemies would have cause to tremble; if his friends were injured, he would take it for granted that they were suffering in a just cause, and immediately rush to their assistance, utterly regardless of all consequences. Our ideas are to do away with partisanship as much as possible, to do away with violent contrasts, to allow every one to think as he likes, to tone down everything, and rather to suspect enthusiasm, whether it is found among our friends or our enemies. We try to judge everything and everybody from an equal standpoint. We do not favor our friends; in fact, we trust them no more than our enemies. We rather feel inclined to criticise our own party more severely than that opposed to us. We make our laws and legal tribunals so lenient that they often become a greater terror to the innocent than to the guilty party. In fact, we dislike contrast and enthusiasm. Of course, this has its good side; but it is not conducive to great art, especially architecture, because architecture, like all other arts, should express the wants and feelings of its time; whereas, how can you express, in brick and stone, the wants of an age which simply "wants to be let alone," or the feelings of a people whose whole study is how to subdue sentiment?

In the middle ages the whole mode of thought was absolutely the reverse of this, and sentiment and contrast were encouraged. The architecture of the period displays these characteristics in a marked manner; it is more impulsive than scientific, more perfect in design than in construction; everything is built not only to serve its purpose, but to express it. If we wander through the streets of a mediæval city, what a contrast there is between the graceful cathedral with the delicate vertical lines of its steeple and the heavily machicolated horizontal parapets of the frowning castle; between the picturesque gabled houses, pierced with many framed windows glistening in the sunlight, and shining out from the intricate confusion of old brown timber beams or ruddy brickwork, like drops of dew upon the leafless tree of autumn, and the massive stone gates and bridge.

In the "good old times" we should have seen still greater contrasts; the frowning castle might have been "garnished" with men hanging, and the bridge by some poor sufferer in the stocks; perhaps a poor widow with her child might be kneeling before the crucifix on the bridge praying for the souls of those whose bones were bleaching on the castle gallows. The law was, indeed, a terror, and delighted in exhibiting and parading itself in its most hateful aspect, and forming in this respect the greatest possible contrast to the church, the surroundings of which all expressed peace, grace, benignity, and beauty.—H. W. Brewer in The Builder.

THE PRESENT STATUS OF THE CAPRIFIG EXPERIMENTS IN CALIFORNIA.*

By L. O. HOWARD, Washington, D. C.

As late as 1895 a writer in Garden and Forest (June 26) gave expression to the following statements, which appear to accurately sum up California conditions with regard to the fig crop down to the present season:

"As a commercial factor the fig has been of little importance among California fruits, although it has been an incumbent of almost every rancher's door-yard since the Padres taught their Indian peons horticulture. As a fresh fruit it is luscious and invaluable for its medicinal qualities. Eaten with sugar and cream, it is as grateful for dessert as the strawberry, and more wholesome; but it is good only when perfectly ripe.

"It will not bear transportation under existing conditions, and the fresh figs offered in Eastern markets are a delusion and a snare. As a dried fruit it has also been a failure in the market. Quantities of dried figs are sold in California, although they are usually small and shriveled in appearance and lack the rich aromatic nutty flavor of the imported fig. The latter commands in California, as everywhere, a high price, usually 25 cents per pound. The home product sells for 10 cents. It has been the dream of fig culturists for years so to improve the quality that the California fruit may compete with the imported. To this end soils, climates, and varieties have been patiently studied."

What this says for California may also be said regarding our Southern States, except that the energetic attempts of Californians to improve the output have not been elsewhere emulated. It is now a generally accepted fact that the Smyrna fig, the fig of commerce, owes its peculiar flavor to the number of ripe seeds which it contains, and since the days of Pliny and Plutarch it has been known that in Oriental regions it has been the custom of the natives to break off branches of the wild or caprifig, bring them to the edible fig, and tie them to its limbs. From the caprifigs thus brought in there issues a minute insect which crawls into the flowers of the edible fig and fertilizes them, thus producing a crop of seeds and bringing about the subsequent ripening of the fruit. The careful investigations of Count Solms-Laubach and Fritz Muller in the early eighties and later those of Dr. Paul Mayr have shown that the varieties of the wild or caprifig are the only ones which contain male organs, while the varieties of the Smyrna fig are exclusively female. In the caprifig there exist three crops of fruit, the first known as "profichi," the second as "mammoni," and the third as "mamme," the latter remaining upon the trees through the winter. The fig insects (the Oriental species being known as Blastophaga grossorum Gravenhorst) over-winter in the mamme, oviposit in the profichi, develop a generation within it, each individual living in the swelling of a gall flower (a modified and infertile female flower), and issue from it covered with pollen, from which they make vain efforts to relieve themselves, enter the young flower receptacles of the Smyrna fig, which are at that time of the proper size, and make an attempt to oviposit in the true female flowers, fertilizing them at the same time by means of the pollen adhering to their bodies, and thus bringing about an extensive production of seed. The life history of the insect from that time on is not well understood. Even Paul Mayr has failed to discover what has become of the blastophaga during the generation of the second crop of caprifigs, known as mammoni. In the development of the third or over-wintering crop, however, the blastophaga is again present, and is thus carried through the winter in condition to oviposit in the profichi of the following spring.

As early as 1880 Mr. Gulian P. Rixford, of California, introduced three varieties of Smyrna figs and a single caprifig tree into that State. In 1885 Mr. E. W. Maslin, of California, planted Smyrna seeds taken from figs imported by the great wholesale grocery house of H. K. Thurber & Company, of New York, and presented to Mr. Maslin for experimental purposes. He grew in four years large and flourishing trees, the trunks of which had in 1889 reached a diameter of from 4 to 6 inches. In 1890 the Division of Pomology of the United States Department of Agriculture imported cuttings of the wild caprifigs from Smyrna, which arrived in excellent condition, a few even retaining and maturing fruit which had set before shipment. These immature fruits all contained caprifying blastophagas, and the cuttings were distributed to twenty-seven persons in Florida, California, Texas, Mississippi, Louisiana, New Mexico, and Arizona, those in California at least taking root and growing with extraordinary rapidity.

Several persons in California were already or soon after became vitally interested in the subject of fig caprification, and in its absolute importance to the fig industry of California. Dr. Gustav Eisen, at that time connected with the Fancher Creek Nurseries, of Fresno, and later curator of biology in the California Academy of Sciences; Mr. E. W. Maslin, above mentioned; Mr. J. C. Shinn, of Niles; Mr. John Rock, a well-known nurseryman of Niles; Mr. Frank A. Kimball, of National City, and Mr. George C. Roeding, of Fresno, were especially interested. Mr. Shinn, through the assistance of a missionary in Syria, imported caprifigs containing blastophagas and endeavored to establish them, but without success. Dr. Eisen studied the subject with great care, corresponded with Count Solms-Laubach, imported with his help cuttings of a number of varieties of both Smyrna and caprifigs, and with the help of Mr. Rock, at Niles, established and has now growing several hundred Smyrna figs of large size and a number of caprifigs, while Mr. Rock has accomplished the interesting result of grafting several varieties of the Solms-Laubach cuttings of caprifigs upon a single Smyrna fig tree, thus producing a tree of great horticultural interest and possibly in the near future of much practical importance. Dr. Eisen prepared and published in 1896 an important paper, entitled "Biological studies on figs, caprifigs, and caprification," in the Proceedings of the California Academy of Sciences, Series II., volume 5, pages 897–1001. Mr. George C. Roeding, at Fresno, in the meantime had started a large orchard of Smyrna and caprifigs, comprising roughly more than 500 trees, of which about 70 were caprifigs. In 1895, through European correspondence, Mr. Roeding introduced caprifigs from Europe containing blastophaga, but failed to bring about its establishment or even, as in former experiments, to secure the production of a single individual offspring from the imported stock on California soil.

From the beginning of the work, the United States Department of Agriculture had been thoroughly alive to the importance of the possible practical outcome. The importation of the caprifig cuttings mentioned above, in 1889–90, was done after consultation between Prof. H. E. Van Deman, then pomologist, and Prof. C. V. Riley, then entomologist, of the Department, for the purpose of establishing the proper host plants in the best possible condition in order that the subsequent importation of the blastophaga by the Division of Entomology would have a reasonable chance of success. (See Annual Report Secretary of Agriculture, 1890, page 414.)

During the winter of 1897–98 the writer, after extensive correspondence with the board of trade of San Francisco, with Dr. Eisen, Mr. Roeding, and Mr. Maslin, decided that the time had come to make a serious and well organized attempt to bring about the desired result. He, therefore, laid the matter before the Secretary of Agriculture and was authorized to undertake the work. He had first thought of having Dr. Eisen, so well qualified by virtue not only of his scientific attainments but also on account of his especial interest in this subject and his well-known investigations and conclusions, commissioned to visit Mediterranean regions for the purpose of collecting additional varieties of caprifigs, of sending over ripe gall figs, and of bringing to this country, if necessary, an entire transplanted and healthy caprifig tree. But it happened that about this time Mr. Walter T. Swingle, a well known botanist in the employ of the Department, was in south Europe, at his own expense, studying at the International Zoological Station at Naples. It happened also that Mr. Swingle was greatly interested in the study of the caprifig and in the caprification by blastophaga. It was decided, therefore, to save the expense of sending a man from America by asking the assistance of Mr. Swingle. The latter, at some personal expense, began in the spring of 1898 to send a number of caprifigs containing gall insects to the Department in Washington for shipment to California, and made a careful study of the question of the different varieties of caprifigs. In April of that year the writer, under commission from the Secretary of Agriculture, visited Mexico on an investigating trip and came northward through California; visiting all of the localities to which caprifig cuttings had been sent by the pomologist in 1890. On reaching Fresno he was at once greatly impressed by the conditions existing at Mr. Roeding's place, and with the energy, intelligence, ability, and general interest in the subject shown by Mr. George C. Roeding himself. Figs growing there, although only six years old, impressed the Eastern visitor with a belief that they could not be less than twenty years old, so extraordinary had been their growth. They were large, healthy, and luxuriant trees. Right through the center of the Smyrna-fig orchard ran a long row of caprifigs, the branches of the two varieties almost interlocking. Moreover, Mr. Roeding had planted in the foothills of the mountains, some miles away, other caprifig cuttings in order to simulate as nearly as possible the climatic conditions under which the caprifig grows most successfully in the Orient. Communicating with Washington, the first shipment of caprifigs from Mr. Swingle fortunately arrived at Fresno while the writer was there. They had been sent from Naples, the locality in which Dr. Paul Mayr had made his studies. Mr. Swingle had adopted an ingenious and eminently successful method of packing. Each green caprifig was carefully and closely wrapped in tin foil, the end being covered with wax. On arrival at Fresno the female blastophagas were seen to be emerging from the gall figs. Unfortunately, however, with them were a number of specimens of Philotrypesis caricæ Hasselquist, the one figured and described by Paul Mayr as Ichneumon phycarius Cavolini. Mr. Roeding readily distinguished between the female blastophaga and this parasite and destroyed all the parasites noticed. By the writer's advice a caprifig tree was inclosed in a thin cloth tent and subsequent sendings of caprifigs were placed in this inclosure and the blastophagas were liberated.

Then a year elasped without result. None of the caprifigs on the inclosed tree were stung by the blastophagas, or if stung no larvæ developed so far as Mr. Roeding could observe, although subsequent developments would seem to indicate that there is a possibility of a partial establishment of the species from the spring of 1898.

In the meantime Mr. Swingle had been transferred to the section of seed and plant introduction of the division of botany, and commissioned as an agricultural explorer to work on the introduction into the United States of desirable plants, with all traveling expenses paid. In the course of his work he went to Greece, and from there sent additional varieties of caprifigs to this country, which were forwarded to Mr. Roeding and planted under differing conditions.

In the winter he went to Algeria and sent other cuttings and one large caprifig tree 10 feet or more high and perhaps 4 inches in diameter. This was also sent to Mr. Roeding, and, although the long journey had apparently reduced its vitality so much that Mr. Roeding feared that it would not live, it was planted, and at latest advices is in excellent condition. As the spring opened, Mr. Swingle again began his sendings of the gall figs, packed as before, and which as before

* From the Proceedings of the Eleventh Annual Meeting of the Association of Economic Entomologists, Bulletin No. 20 of the Division of Entomology of the United States Department of Agriculture.

were placed by Mr. Roeding under the artificial inclosure. On March 31, 1899, six boxes of caprifigs were received by the writer and forwarded to Mr. Roeding; on April 5 one more box, and on April 6 the eighth and last. On April 6 the first boxes were received by Mr. Roeding. The fruits seemed to be in excellent condition. He cut several open, and found them full of blastophagas in the pupa condition. All of the figs were cut open and placed under the covered tree.

It must here be said that none of the persons connected with the work had much hope of the establishment of the fig insect by this method, on account of previous failures. It was tried because the opportunity offered and because of the variations referred to in the method of packing and the careful tenting of the single tree, in the hope that some might succeed in finding fruit of the right size for entering and for oviposition. Mr. Roeding, in acknowledging the receipt of the sending of March 31, and promising to cut them open and put them under the covered tree, said: "But I anticipate no results, and I do not think a success will be made of this matter until fig trees with the figs attached are sent out here during the winter months." Most of the figs shipped from Washington on the 5th and 6th of April arrived at Fresno in a decaying condition.

In view of everything which has so far been said in this paper, the pleasure of the writer on receiving the following telegram from Mr. Roeding will readily be understood:

"FRESNO, CAL., June 23, 1899.

"Dr. L. O. HOWARD,
"Chief Entomologist, Washington, D. C.:
"Great surprise. Blastophaga developed in caprifigs. Send instructions. GEO. C. ROEDING."

This was followed on the next day by the following dispatch:

"FRESNO, CAL., June 24, 1899.

"Dr. L. O. HOWARD,
"Chief Entomologist, Washington, D. C.:
"Twenty figs tented tree; insects pupa state; one fruit outside; winged insects now escaping; fruit hanging Smyrna tree; letter and fig mailed.
"GEO. C. ROEDING."

The letter referred to contained the interesting statement that the figs with the insects in them were discovered by accident. One of Mr. Roeding's men was engaged in gathering caprifigs and extracting the pollen for the purpose of artificially pollinating Smyrna figs by means of a blowpipe. He ran across one fig which apparently contained seeds, but which Mr. Roeding found were in reality galls. The fig was taken from the covered tree, and about the 24th of June all of the figs on the same tree had dropped and shriveled up, with the exception of about twenty, which were still green and plump, and which subsequent evidence showed contained developing blastophagas. Another fig outside of the covered tree was found later in the same day, from which a winged blastophaga was in the act of emerging. This fig was immediately tied on one of the Smyrna fig trees. A day later ten more figs on an outside tree were found to contain the blastophaga. The penetrating power of the female blastophaga was shown by an interesting experience of Mr. Roeding. On June 29 he picked half a dozen caprifigs and, placing them in a glass jar covered with cheese cloth, started for his foothill farm, where he has some caprifigs growing. On the journey about one hundred blastophagas emerged, and were quite lively, flying around in the jar. On arrival he found upon examining the cheese cloth that at least a half dozen of the insects were forcing their way through the cloth, and some were crawling on the outside.

On June 29 all the wild figs left under the tented tree and those on the outside tree, with the exception of one, were picked and hung in other wild fig trees upon which young fruits, presumably mammoni, were beginning to develop. On the 30th of June a most interesting discovery was made. A tree 1,500 feet away from the tented tree was found bearing two caprifigs containing galls and male insects.

About the middle of July Mr. Roeding found Smyrna figs which had been fertilized by the blastophaga. By July 19 not only was the difference between these figs and the unfertilized Smyrna figs most striking, but the difference between them and those which had been artificially pollinated was also very marked. The unfertilized Smyrna fig is hollow, can easily be squeezed together by the fingers, and drops to the ground before it is more than three-fourths of an inch in diameter. The figs which Dr. Eisen and Mr. Roeding have been able to artificially fertilize by collecting pollen from the caprifigs and introducing it into the orifice of the Smyrna fig by means of a toothpick or blowpipe become rather firm, and on reaching maturity contain many ripe seeds, probably not more than half, however, of the number of ripe seeds that may be found in the average imported Smyrna fig. Those found by Mr. Roeding which had been pollinated by the blastophagas, however, were by the 19th of July more than twice as large as the unfertilized ones, were solid and firm, and literally packed with ripe seeds surrounded by tissue of a beautiful pink color. On the same date (July 19) caprifigs were found full of what seemed to be galls. Dissection, however, showed that all of the seed-like objects which were cut open were really seeds and not galls. The precise variety of caprifig in which this phenomenon was noticed is not known to Mr. Roeding. It contains male flowers, however, and is with little doubt a caprifig. The mammoni flowers, as is well known to investigators, occasionally develop a certain number of ripe seed.

What the outcome will be from this time on is difficult to predict. The blastophaga has been successfully introduced and has bred profusely for one generation. Whether it will breed in the mammoni caprifigs we cannot tell as yet. It has not been found to do so in Europe, as previously stated. The third crop of caprifigs in Mr. Roeding's home orchard, near Fresno, invariably drop during the winter, but he has found that in caprifigs growing at his foothill place the figs hang on during the winter. He has made every effort to introduce blastophaga at that place also, and it is very possible that the insect will successfully hibernate there, if it does not do so at the valley place. There is even a strong possibility that no more importation may be needed. There is also a possibility that the insect will die out owing to variation in season of blooming of the caprifig, and owing to the fact, perhaps, that the right varieties are not growing at Fresno. The present year's experience, however, has shown that the insect can be brought over and can establish itself. We know the proper date and we know where to get the blastophagas at the proper date. Thanks to Mr. Swingle's idea of sending over the mamme, or over-wintering caprifigs, instead of those of the profichi or spring crop, which were the ones invariably sent in the earlier private attempts which we have mentioned, and thanks also to his excellent method of packing, the successful introduction for a season at least may be repeated indefinitely and with certainty. Efforts will now be made to introduce and to grow in different parts of California every possible variety of caprifig, and it is safe to say that what once seemed so difficult, if not improbable of accomplishment, is now comparatively certain, and there is every reason to believe that in the near future California will be growing and marketing dry figs which will rival the commercial product of Oriental regions.

PROBLEM OF HONEYCOMB.

By CHARLES DAWSON, F.G.S., and S. A. WOODHEAD, B.Sc., F.C.S.

THE hexagonal arrangement of the cells of honeycomb has been generally ascribed to a structural instinct on the part of the bees; the object of this paper is now to show that the form of the bee-cell is chiefly influenced by a "crystalline" hexagonal formation due to the cooling of the wax.

While experimenting with waxes and resins, one of us (Mr. Dawson) noticed that on cooling the mixture had a tendency to arrange itself in hexagonal forms, from which he surmised that the outline of bee-cells might be primarily due to the natural structure produced in cooling wax. At the instance of Mr. Woodhead, who also recognized the analytical importance of such a discovery, it was agreed to work out the details together in Mr. Woodhead's laboratory at the Agricultural College, Uckfield.

It was first of all determined that although the addition to beeswax of resinous substances gave a more pronounced and bolder outline to the hexagons, no such addition to beeswax was necessary for their production.

If a thin slab of beeswax be melted in a shallow tray (measuring, say, 10×8 inches), which is evenly heated throughout, and is then placed to cool gradually in a warm atmosphere without draught, hexagonal crystalline forms, of the ordinary size of a worker-cell of the hive-bee, will be seen gradually forming at the bottom of the dish. And a similar line of hexagons will be seen to form on the surface of the wax round the sides of the dish where the wax first cools. The sides of the hexagons are to be seen forming and branching out in advance of the cooling wax, and when a portion of the wax in the center of the dish alone remains melted, the remaining hexagons form very rapidly and almost appear to flash out upon the surface.

The tray should be exactly level and the wax about 1·5 mm. thick and of uniform depth, and the atmosphere of even temperature (say a few degrees below the melting-point of the wax), otherwise the hexagons will be irregular in size and shape.

It is immaterial how thin the plate of wax is, as the hexagons are formed in any case, but their size is undoubtedly regulated by the thickness of the plate of wax, the rule being, the thinner the plate the more minute the individual hexagon. The same result may be obtained on a much smaller scale, so as to produce only one or two hexagonal forms, but the operator will then find that the difficulty lies in the rapid cooling at the sides of so small a mass of wax.

The explanation of the formation of these hexagonal bodies is as follows:

On cooling, the wax at first forms into nuclei of nearly equal size. On the shrinking of the wax by further cooling, these nuclei or spheroids are pressed together, forming planes at their points of contact. Should the wax be rapidly chilled before these spheroidal bodies are formed to their full extent, they are then prevented from coming into contact one with another by the intervening nebulous masses of "uncentralized" particles of wax. It would appear by microscopic examination that these particles are also smaller nuclei which become absorbed in the larger. They also, like the larger, assume hexagonal form. In this state the nuclei appear when cold as solid circular bodies.

The hexagons appear very distinctly above and below the surface while the wax is cooling. When it is actually solid, their forms are often very indistinctly seen, or may be altogether invisible, but they are none the less present. The bases of these hexagons, which lie mid-way between those visible at the top and those at the bottom, are pointed and are arranged so that the point of the base of the upper hexagon coincides with the points of contact of the lower hexagons as in the honeycomb. These bases can be observed by making a very thin microscopic section, but several hundred sections had to be examined before they were made out with certainty.

When a small amount of resin and turpentine is added to bees-wax and melted, and the mixture is allowed to get cold, the outlines of the planes of contact on the hexagons are more distinct and are to be seen raised upon the surface. Under these circumstances they may be easily rubbed with black lead, which still further increases their visibility.

Our chief experiment was next to put our theory to a practical test, and observe in what manner the bees would deal with a cast sheet of pure beeswax, which, when viewed by a side light, distinctly showed traces of these natural hexagons over its surface.

Before introducing it to the bees, we had traced upon it with vermilion a group of the hexagons which appeared near the center of the plate. (Another group we black-leaded.) This was then photographed, after which the wax plate was placed in an observatory-hive on a bar-frame. The bees soon started upon it, proceeding to excavate round hollows in the centers of the hexagons, at the edges of the plate, pushing out on all sides the débris around the edge of each excavation. When they reached the planes of contact of the hexagons, either on feeling the minutely raised edges on the surface, or more probably on feeling the increased density of the wax, the bees determined the limits of their excavation; and it was then discovered by us that the bases of these hexagons were three-sided in the usual form of a bee-cell. There are two reasons for the density of the wax, namely, the outer edges of the nebulæ are composed of smaller particles and are therefore more compact, also the pressure brought to bear on the planes of contact renders the sides of the bodies still more compact. Meanwhile, a similar process was going on in the cells which lay as nearly as posible in the same irregular wavy line, but the work on one side of the sheet was sometimes considerably more advanced than on the other, the excavation being brought three or four more rows of cells nearer the center on one side than on the other.

Portions of the débris taken from the center of the hexagon were now kneaded up by the bees into a kind of froth, and placed above the lines of pressure or margins of the hexagons, the residue of the débris being put aside for future use.

The portions placed on the margin of the hexagons speedily adhered and solidified, another layer was then added by the bees, and this process was repeated, thus forming a series of strata (which may be noticed under a magnifying glass on the sides of the complete cells); the bees planing and polishing the inner surfaces of the cell upward from the base, taking as guides the planes and angles of the hexagons.

In the places where we had traced the outlines of the hexagons in vermilion, the bases of the cells were to be distinctly seen formed upon the vermilion outlines.* Similar experiments have been repeatedly tried with the same results.

In places where the wax plate had been of uneven depth, or had cooled too rapidly, the comb presented an irregular appearance following in form the irregular "crystalline" bases beneath, the result being very distinctive and striking to the practised eye of an apiarist.

When in a natural state the newly secreted wax is formed into a small pendent plate, it is probable that the bees crowding around produced the required amount of heat to soften or to keep soft the newly deposited wax, and allow it to cool very gradually when a few "crystalline" bodies form within the plate, and these must be soon afterward hollowed out and built upon. The same process takes place repeatedly against the sides of newly formed hexagons until the comb is large enough to suit the requirements of the bee; the size of the cells being partly influenced and regulated as above stated by the rapidity or otherwise of the process of cooling of the wax, and so indirectly, as previously mentioned, by the thickness of the cooling mass. The size of the hexagons may be varied experimentally from those of nearly an inch across to others of microscopic dimensions.

At the time of writing this paper, we have not yet succeeded in casting a large sheet of wax containing groups or rows of hexagons so perfectly regular as those which are to be seen in a natural comb, or in a comb built upon the ordinary manufactured comb-foundation. We do not pretend, even after many experiments, to be able to cast a foundation of hexagons with the same comparative exactitude as those made by the bee. Although we have little doubt that we may soon be able to do so, we cannot expect, in a few limited experiments, to compete with the bee, whose seeming aptitude is probably the outcome of ages of natural selection and adaptation. Yet the bees still prefer to adopt our less regular groups or rows of hexagons as bases to work upon, rather than pull our wax plate to pieces, so as to recast the wax with greater regularity.

A further outcome of our discoveries is that paraffin wax and adulterated beeswax do not assume the same "crystalline" form as pure beeswax.

We have succeeded in producing a variety of characteristic forms of these "crystalline" bodies by the treatment of certain waxes with other fats, oils, or waxes. The analytical value of these experiments we may hope to prove to be very great, both directly and indirectly, and to open up an immense field of crystallography in its relation to oils, fats, and waxes.

It has also naturally occurred to our minds that the formation of certain intricate structures by other insects may be also more or less directly due to crystalline and pseudo-crystalline formations.—Natural Science.

* A plate of wax formed by compression, and in which no hexagons had formed, was inserted in the hive; this the bees gnawed to pieces and (?) utilized elsewhere.

Reviewing the shipbuilding industry of 1899, The Glasgow Herald estimates the shipping output for the year at 1,713,000 tons as compared with 1,661,000 tons in 1898, in which year the amount of tonnage launched exceeded all previous records. The output on the Tyne, Thames and Humber this year has fallen somewhat short of that of 1898; but all other districts show an increase, and, as usual, the Clyde heads the list with an output of 491,074 tons, or more than one-fourth of the entire production of the year. With regard to the year's work, two special features are noted. One is the almost entire extinguishment, so far as new building in this country is concerned, of the sailing vessel. "Not a single ton of the old 'sailing' class of ships," we are told, "has been constructed this year by any of the Clyde yards." And the other feature has been the enormous size of the steamers that have been built during the year, not here alone, but in other countries, as to which our contemporary writes: "An admirable example of the new leviathans, the Saxonia, was launched from Clydebank on Saturday. This latest addition to the Cunard fleet possesses a gross tonnage of 13,900, and is expected to be able to carry no less than 20,000 tons of cargo. Another steamer of an almost equal size, the Ivernia, was launched earlier in 1899 for the same company, while the White Star line and various lines in Germany and the United States have also had equally mammoth ships built for them. The full meaning of the late development in size of steamers has not yet, perhaps, been properly grasped, but no doubt it is partly due to the fact that, while the larger vessels will carry a great deal more than those of smaller dimensions, the working cost will only be slightly increased."

THE INSECT FOES OF TOBACCO.

TOBACCO, like all cultivated plants, has numerous enemies. Some of these, such as species of Orobanche, which lives as a parasite upon its roots and sometimes greatly injures its vegetation, belong to the vegetable kingdom. Some belong, also, to the animal kingdom, and the world of insects in particular furnishes a large number of them. Targioni, Tzozetti, Garman and Quaintance have published important works upon this subject, and quite recently Dr. L. O. Howard, an American entomologist, in a work entitled "Insects Injurious to the Tobacco Plants of the United States," has called attention to a certain number which do considerable damage and which, it appears, have never before been mentioned by any author. These are new foes, which we believe it well to make known to our readers.

The most injurious of all is a very small brownish-red beetle (Fig. 3, No. 1), the Epitrix parvula Fab., which is very much dreaded in Arkansas, Florida and Connecticut, and which in the first place attacks the leaves at the bottom of the plant and then those at the top. These leaves exhibit in the first place small dry spots, and, later on, small apertures, like punctures made by pins, which afterward enlarge (Fig. 3, No. 3). The female lays her eggs upon the roots. From these eggs there soon emerge radicicolous, whitish larvæ (Fig. 3, No. 2), which, according to Clittendel, develop in a month. The damage done by them is not so serious as that done to the leaves by the adults.

This little beetle lives also upon the thorn apple (Datura) and various other Solanaceæ, which particularly attract it, so that they may be used as vegetable traps for its destruction by leaving a few isolated plants in the tobacco fields.

In the apertures made in the leaves by the Epitrix, spores often develop and cause a disease which is sometimes more serious than that produced by the insect itself, especially during the wet season. The leaves (Fig 3, No. 4) are then covered with white, circular spots formed by a fungus—the Cercospora nicotinæ, vulgarly called "frog's eye." (Ellis and Everhart think that these white spots are formed by the Macrosporium tabacinum.) The upper leaves of the plant are then spotted and punctured by the insect, while the lower ones are almost covered with small white disks.

In order to fight the Epitrix, it is necessary at the outset to destroy the weeds in the tobacco fields, and especially the Solanaceæ. After this the plants, as they emerge from the earth, should be dusted with a mixture composed of one part of Paris green and twenty parts of flour or any other pulverulent substance. A mixture containing a large proportion of Paris green is likewise spread upon the ground at the time of plowing, in order to kill the insects that are hibernating; and, after the plants are sufficiently developed, they are sprinkled with a liquid composed of one pound of Paris green and 105 gallons of water.

The lepidopters furnish a large contingent of enemies to the tobacco plant.

Among them there are, in the first place, two sphinxes, the Protoparce Carolina and the Protoparce Celeus, vulgarly called "horn-blowers" (Fig. 1), the caterpillars of which are striped with white, and live also upon other Solanaceæ. The horn of the first named is red, while that of the second is black. The moths of the two species closely resemble one another. The P. Carolina has darker wings, and the orange-colored spots on the abdomen are brighter. It is the more common of the two species, and is found further toward the south. These two sphinxes are hatched between May and June, and the moths lay isolated eggs on the underside of the leaves. The caterpillars develop in one month, and pass the chrysalis state in the ground. Like some other species, they are attacked by parasites such as the Ichneumon and Tachina flies. In warm regions there are several generations a year.

In America the following method is employed for destroying these moths:

Some Datura flowers are gathered and stuck into the ground, and into them is introduced, through a goose feather, a poisoned liquid composed of one ounce of cobalt, a quarter of a pint of molasses and one pint of water. The moths, upon sucking up the saccharine liquid with their long tongues, are quickly poisoned.

The Datura is cultivated in Louisiana expressly for this purpose, and the late Townsend Glover advised the use of artificial Datura flowers of tin or porcelain, poisoned in the same manner.

In Maryland, Prof. Johnson has tried an arsenical solution put into a wooden pail perforated near the bottom and placed in an earthen pan, and the whole raised upon supports above the tobacco plants. The insects visit the arrangement in large numbers, it seems, to suck up the poisoned liquid.

FIG. 1.—PROTOPARCE CELEUS AND ITS CATERPILLAR.

Two species of Heliothis—H. Rhexia, S., and Armiger, Hb. (Fig. 4, No. 1) also are very injurious. The caterpillar of the first is known by the name of the "true mud-worm," and that of the second by that of the "false mud-worm."

These caterpillars, which are rather rare in the spring, become very abundant in August. They pass the chrysalis state in the ground, and the moth generally appears in September. Toward the end of this month and in October a new generation of caterpillars makes its appearance, and lives in the capsules and even in the stalks (Fig. 4, No. 2). The insects, consequently, destroy the seeds. They live also upon other plants, such as cotton, ground cherry, wheat, etc. The H. Armiger is the "ball-worm" of the Southern States, so destructive to cotton crops. Arsenical powder is said to give good results as an agent for the destruction of these insects, and deep plowing is recommended as an efficient means of destroying the chrysalis.

A very small gray moth, known to naturalists as Gelechia solanella, Bdv. (Fig. 4, No. 4), and which produces several generations a year, has sometimes shown itself very injurious, especially in North Carolina. Its caterpillar lives in the parenchyma of the leaves (Fig. 4, No. 3), and even in the stalks and capsules. It is polyphagous, being found upon the tomato, egg plant, etc. Farmers sometimes attribute to humidity the damage that it causes. This same species is found likewise in Algeria and was described by Ragonot under the name of Tabacella. Arsenical solutions give good results as agents for its destruction; and in regions where its first generation appears before the tobacco plant has sprouted, it is of great importance to destroy other Solanaceæ that might harbor it.

FIG. 2.—CHRYSALIS OF PROTOPARCE CELEUS.

The caterpillars of several species of Agrotis, known popularly as "cut-worms," are also very injurious. They are destroyed by mowing the grass after there has been spread over it a mixture composed of one pound of Paris green and sixty pounds of bran moistened with water and sweetened with molasses. The grass is left lying upon the ground. This mixture destroys grasshoppers also; but it is dangerous for cattle and poultry.

After a mere mention of a few Noctuidæ, such as Plusia Brassicæ and Mamestra legitima, we shall have finished with the Lepidoptera.

An hemipterous insect, Dicyphus minimus, which usually lives upon the tomato (Fig. 5, No. 6), has become very injurious to the tobacco crop, during the last ten years, principally in Colombia, and especially in late harvests. It sucks the sap of the leaves, which become yellow and die. The larva lives upon their lower surface. It is fought by means of a solution of nicotine employed by preference in the morning before the insect has resumed its full activity. Another bug (Fig. 5, No. 7), the Euschirius variolosus, also causes great havoc at times.

The Aleyrodes tabaci, Gen., the white tobacco fly, which lives on the lower surface of the leaves, has been mentioned as injurious in Greece.

A thrips, T. tabaci (Fig. 5, No. 5), vulgarly known as the "onion thrips," has been pointed out as injurious in southern Russia.

FIG. 3.—EPITRIX PARVULA.

1, perfect insect, greatly enlarged; 2, its larva, greatly enlarged; 3, leaves punctured by the Epitrix; 4, leaves attacked by Cercospora nicotinæ.

FIG. 4.

1, Heliothis armiger; 2, capsules containing caterpillars of the Heliothis; 3, leaf mined by the caterpillar of Gelechia solanella; 4, the moth.

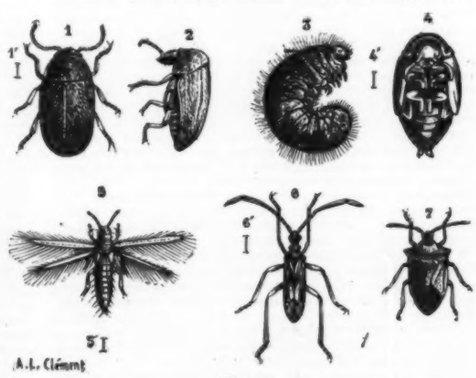


FIG. 5.

1, Lasioderma sericorne, greatly enlarged; 1', natural size; 2, profile view of the same; 3, larva, greatly enlarged; 4, chrysalis, greatly enlarged; 5, Thrips tabaci; 5', natural size; 6, Dicyphus minimus; 6', natural size; 7, Euschirius variolosus.

The female of the cricket (Œcanthus fasciatus), called in Maryland "gabberer" or "chatterer," doubtless from the song of the male, introduces its eggs into the stalks of the plants, and sometimes proves very detrimental to them through its stings, as do a certain number of other insects that we shall pass by without mention.

Tobacco in a dry state has also very numerous enemies among insects; for example, the Cigarette beetle, the Lasioderma serricone, Fab. (Fig. 5, Nos. 1 to 4), which is often seen making its exit from cigars and cigarettes through small round holes. It is a singular thing that certain smokers prefer cigars thus damaged to others, not only on account of their cheapness, but also because of their peculiar taste. The Dermestes vulpinus has been known to give rise to a litigation between France and the United States on account of its having developed en masse in a cargo en route. Certain caterpillars that have lived upon the leaves of tobacco in a growing state continue to eat them after they have been cured.

In stores and manufactories, the use of hydrocyanic acid and of sulphide of carbon suffices to destroy these ravagers; but it must not be forgotten that the vapors of sulphide of carbon form detonating mixtures with the air in a closed space.—For the above particulars and the illustrations, we are indebted to La Nature.

RECENT IMPROVEMENTS IN RICE CULTURE.

By Dr. EUGENE MURRAY-AARON.

IN 1898 the United States used 190,285,315 pounds of imported rice, and produced a crop of 116,401,760 pounds. Of barley, maize, oats, rye, and wheat, we produced at the same time, in addition to the domestic consumption, an export quantity of 24,205,469,356 pounds. In the case of rice, we produce less than half the amount we consume; of all the others an enormous surplus for export. This is due to the fact that rice, in addition to its subtropical character, is a crop growing chiefly on wet lands, where it has hitherto been impossible to use harvesting machinery. It must, therefore, be cut with a sickle, and American hand labor has been thrown into competition with the cheap labor of the tropics, a competition that has not proved profitable to the American.

In 1884, enterprising settlers in Louisiana began the development of a new system of rice culture, by which, as now perfected, the dry prairie lands are flooded by a system of pumps, canals, and levees, and when the rice is about to mature the water is drained off, leaving the land dry enough for the use of reaping machines. Under this system the cost of harvesting, and, therefore, the total cost of production, has been greatly reduced and the industry has undergone a rapid development.

In September, 1898, Dr. S. A. Knapp, of Louisiana, was appointed by the Secretary of Agriculture as an agricultural explorer, with instructions to visit Japan, investigate the rices of that country, and purchase a stock suited to meet the requirements of the American problem. Dr. Knapp returned in the early spring of 1899 with ten tons of Kiushu rice which was distributed to experimenters in southwestern Louisiana and elsewhere. Dr. Knapp has just submitted a report to the department,* of which this article is an epitomization, the careful study of which must amply repay anyone specially interested in rice culture.

Where dense populations are dependent for food upon an annual crop, and considerable diminution in the supply would result in starvation for many, rice has been selected as the staple food wherever climate permits its cultivation. Under such conditions certainty of supply is of first importance. The estimated total population of the Chinese empire, of the British possessions in Asia, of Japan, and of other rice-eating countries is 826,000,000. It is estimated that rice constitutes fully half of the entire food supply of these nations.

There is an immense variety in cultivated rice; it differs in length of the season for the maturing, in character, yield, and quality. The divergence not only extends to size, shape and color, but to relative proportion of food constituents and the consequent flavor. South Carolina and Japan rices are rich in fats, and much esteemed above Patua, which is very poor in fats, as well-fattened beef is esteemed superior to the lean animals of the range. A botanical catalogue enumerates 161 varieties found in Ceylon alone, while in Japan, China, and India, where great care is taken in improvement by the selection of seed, probably 1,400 varieties exist.

Rice production in the United States is limited to the South Atlantic and Gulf States, where in some sections it is the principal cereal product. Recently Louisiana and Texas have increased their rice area so that they now furnish three-fourths of all the product of the country.

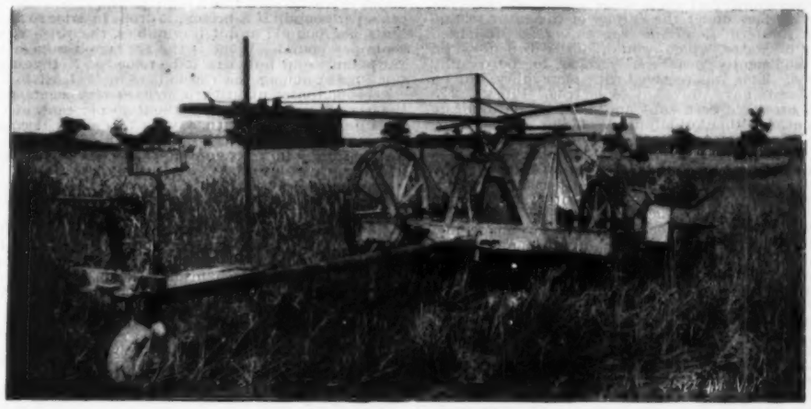
Rice is of such vigor that it could be grown on any arable land as far north as the Ohio River but for three reasons:

First.—The crop must be irrigated. The smaller tributaries of the rivers that drain the Mississippi Valley and the small creeks and streams emptying directly into the Gulf bring down very little water during the summer. The flood period is not coincident with the period during which the most water is required by the rice crop. In the absence of natural reservoirs throughout this region it would be necessary to raise the water by pumping, and it is an open question whether the water supply would be large enough for any extended area.

Second.—Rice, in its best development, also requires a moist climate. With irrigation alone rice would mature in the mountains of Tennessee, but it would not compare in quality or quantity with the crops of the coasts, and could not compete in the world's markets. As an example, in southwestern Louisiana the winds from the Gulf are laden with moisture, but the north winds are dry, and consequently the lands along the south side of a lake or large pond usually produce two barrels per acre more than the north side, although other conditions of soil and moisture may be equal.

Third.—The best rice lands are underlaid by an impervious subsoil. Otherwise the land cannot be satisfactorily drained in order to use improved harvesting machinery. The alluvial lands along the Mississippi Valley in Louisiana are not underlaid by hardpan, and cannot be drained sufficiently for heavy harvesters and teams of horses.

According to the best estimates, the suitable area which can be successfully irrigated by present methods, using the available surface, and artesian flows, does not exceed 3,000,000 acres. Much more could be brought into cultivation were it necessary, but the cost would, perhaps, be prohibitive at present prices. The best results require rotation of crops; consequently only one-half of that amount, or 1,500,000 acres, would be in rice at any one time. At an average yield of 10 barrels (of 162 pounds) per acre, 1,500,000 acres of rice would produce nearly 2,500,000,000 pounds of cleaned rice; nearly six times the amount of our present consumption. The crop harvested in 1899 is said to be the largest which has ever been grown. It would appear that the demand for rice is increasing in the United States.

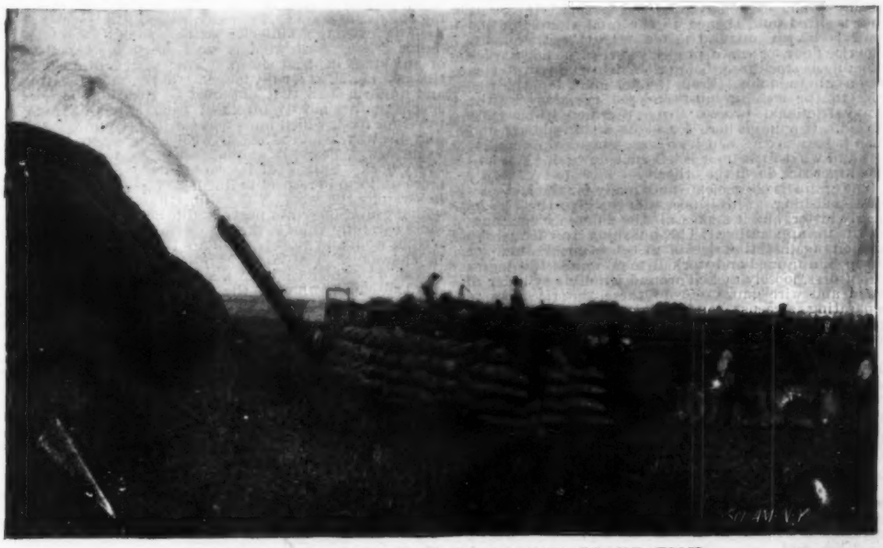


A RICE CUTTING MACHINE.

HARVESTING RICE ON A LOUISIANA PLANTATION.

The outlook for the industry is very promising. There has been recently quite an awakening among farmers to the importance of this industry, so that there have been large annual increases in the area planted. There is no satisfactory reason why we should not grow all of our own rice, nor why we should not become exporters.

The use of machinery in the rice fields, similar to that used in the great wheat fields of California and the Dakotas, is resulting in a revolution in cultivation on the prairie along the coast from the parish of St. Mary in Louisiana to the Texas line, about 140 miles. Finding that rice, grown for many years by Oriental methods, was well suited to the conditions here, they commenced immediately to adapt the agricultural machinery to which they had been accustomed to the rice industry. The gang plow, disk harrow, drill, and broadcast seeder were readily adjusted, but the twine binder encountered a number of serious obstacles. However, by the close of 1886 the principal difficulties had been overcome. Wherever prairies were found sufficiently level, with an intersecting creek which could be used to flood them, they were surrounded by a small levee. The land was so level that fields of forty and eighty acres were common. Large crops were produced, the prairies were practically free from injurious grasses, and the creek or river water was soft and bore no damaging seeds to the fields. The rice fields were handled like the bonanza wheat farms of Dakota, and fortunes were made; the main object being apparently to plant a large acreage and secure a certain



CYCLONE THRASHER AT WORK ON RICE PLANTATION.

* The Present Status of Rice Culture in the United States. By S. A. Knapp. United States Department of Agriculture, Division of Botany, Bulletin No. 22. 56 pages, 3 plates. Washington, 1899.

yield, regardless of quality. Ultimate failure was certain, but it was hastened by drought. A succession of dry years followed. The creeks failed, and reservoirs were found to be expensive and unreliable.

To provide a reliable supply of water, plants for pumping were substituted for natural irrigation. Fortunately the water in the rivers is soft, abundant, and free from silt and damaging weed seeds. The elevation of the prairies above the streams varies from 6 to 38 feet, the larger portion being from 15 to 25 feet. Scarcely had canals been accepted as a success when it was announced that there were strata of gravel at 125 to 200 feet under the surface of the entire section in southwestern Louisiana containing an unlimited supply of water, which would, of its own pressure, come sufficiently near the surface to be readily pumped. This was received with incredulity, but repeated tests have proved it to be true. Pipes of 2 to 8-inch size have been sunk and pumped continuously for months without diminution of the supply. The water is soft, at a constant temperature near 70 degrees, and free from injurious seeds or minerals. A 6-inch tube has been put down to the full depth required, 200 feet, in fourteen hours. It has been found that a 2-inch pipe furnishes sufficient water for ten acres of rice, and a 6-inch pipe will flood eighty to ninety acres. Any number of wells may be made, and even if no more than 30 or 80 feet apart, one does not diminish the flow from the other.

Rice follows the law so well established for wheat and other cereals, that thorough cultivation both increases the quantity produced and improves the quality and flavor. Some have claimed that rice, being a water plant, does not follow this rule. This is an error. The rice of commerce is an improved variety, far superior to wild rice, and the improvement has come through better environment. We have not yet reached the limit of possible improvement in rice by any means.

When rice is ready for the harvest, cutting proceeds rapidly. The length of straw to be cut is a matter of option, but if cut in the stiff dough state of the kernel, sufficient straw must remain with the head to enable the grains to mature. On an average 2½ feet of straw will be found practical. The smaller the bundle, the better for curing. While care should be exercised in all the various processes of rice production, it is most necessary in shocking, which is generally left to some boy who can do nothing else. Thirty per cent. of the crop may be lost by improper shocking. Slow curing in the shade produces that toughness of kernel necessary to withstand the milling processes. In the shock every head should be shaded and sheltered from storm as much as possible. The rice should be left in the shock till the straw is cured and the kernel hard.

With the large steam thrashers there is frequently considerable breakage and waste of grain. Great care must be exercised to avoid this and preserve every part which has been won from the soil with such labor. At the commencement of thrashing, examination should be made to see that there is no avoidable breakage of the grain. The primitive method of milling rice was to place a small quantity in a hollow stone or block of wood and pound it with a pestle. The bran and hulls were then removed by winnowing. Later, the receptacle for the rice was made out of a short section of a hollow log, using a heavy wooden pounder bound to a horizontal beam 6 to 8 feet long, resting on a fulcrum 4 to 5 feet from the pounder. This was raised by stepping on the short end of the beam, and by suddenly removing the weight the pounder dropped into the rice tub and delivered a blow. The end of the pounder was concave, with edges rounded. This simple machine and the fanning mill are in common use in Oriental countries to-day. Looking to the right or left, one sees a rice mill, consisting of a one-man power jumping on and off the beam of the pounder and one-woman power at a crude fanning mill cleaning the grain.

The improved processes of milling rice are quite complicated. It is first screened to remove trash and foreign particles. The hulls, or chaff, are removed by rapidly revolving "milling stones" set about two-thirds of the length of a rice grain apart. The product goes over horizontal screens and blowers, which separate the light chaff and the whole and broken kernels. The grain is now of a mixed yellow and white color. To remove the outer skin, the grain is put in huge mortars holding from four to six bushels each and pounded with pestles weighing 350 to 400 pounds, which, strange to say, break very little grain. When sufficiently decorticated, the contents of the mortars, flour, fine chaff, and clean rice of a dull, creamy color, are removed to the screens, where the flour is sifted out; thence to the fan, where the fine chaff is blown out and mixed with the other flour. The rice flour, or more properly "rice meal," is very valuable as stock feed, being rich in carbohydrates as well as albuminoids. From the fine-chaff fan the rice goes to the cooling bins, rendered necessary by the heavy frictional process through which it has just passed. It remains here for eight or nine hours and then passes to the brush screens, whence the smallest rice and what little flour is left runs down one side and the larger rice down the other.

The grain is now clean and ready for the last process—polishing. This is necessary to give the rice its pearly luster, and it makes all the difference imaginable in its appearance. The polishing is effected by friction against the rice of pieces of moose hide or sheep skin tanned and worked to a wonderful degree of softness, loosely tacked around a double cylinder of wood and wire gauze. From these the rice goes to separating screens, composed of different sizes of gauze, where it is divided into its appropriate grades; it is then barreled and ready for market.

In mills more recently erected, the foregoing process has been modified by substituting the "huller" for the mortar and pounder. A short, cast iron, horizontal tube with interior ribs and a funnel at one end to admit the rice, has within a shaft with ribs, so adjusted that the revolution of the shaft creates the friction necessary to remove the cuticle. The rice passes out of the huller at the end opposite the funnel.

It is to be regretted that fashion has so much to do with rice. A high gloss is required, to obtain which the most nutritious portions are removed. The Oriental custom of removing the hulls and bran with a pounder and using the grain without polishing is economical and furnishes a rice of much higher food value than the rice of commerce. In polishing, nearly all the fats are removed. In 100 pounds of rice polish there are 7·2 pounds of fats; in 100 pounds of polished rice there is only 0·38 pound of fat. Upon the theory that the flavor is in the fats, it is easy to understand the lack of it in commercial rice and why travelers universally speak of the excellent quality of the rice they eat in Oriental countries.

We are now prepared to understand the loss by breakage of the kernel in milling. If the grain remains whole and receives a high polish, it sells for 6¼ cents per pound. If it breaks, it drops in price to 2 or 3 cents per pound; and if it crumbles, the price is 1⅝ cents per pound. What is the average breakage per 100 pounds and how can it be remedied? Investigations made among the rice millers in 1897 led to the conclusion (based upon their written statements) that the perfect grains were only about 40 per cent. of the total product. It is with a view to greatly decrease this heavy percentage of loss that the Department of Agriculture is now attempting to introduce the hard, firm rice from the island of Kiushu, Japan.

Dr. Knapp's report contains much interesting matter as to the details of improvements in rice culture, yet to be adopted, as well as a fund of information as to the history, the comparative costs, and other differences in the rice-cultivating countries. Among his table of relative costs, the following exhibits the invincible nature of mechanism, backed by human ingenuity, when finally brought into contact with crude and primitive methods:

NUMBER OF ACRES ONE MAN CAN FARM IN RICE, WITH WAGES, IN DIFFERENT COUNTRIES.

Countries.	Acres.	Farm wages in gold per year, with board.
Japan	½	$10 to $18
China	½ to 2½	8 to 12
Philippines	2½	15 to 20
India	3	10 to 20
Siam	3	10 to 20
Egypt	4	15 to 30
Italy	5	40 to 60
Spain	5	40 to 60
United States:		
Carolinas	8	96 to 120
Mississippi delta	10	120 to 144
Southwestern Louisiana and Texas	80	180 to 216

In a word, the laborer of Japan, although averaging a wage of less than $15 a year and his board, caring for but one-half acre of rice, produces that crop at a cost of $35 to $50 per acre, above his board; while the Texan laborer, paid fifteen times the wage, with his improved implements and methods, cares for eighty acres, at a cost of less than one-tenth that possible to the Oriental. And, as Dr. Knapp makes quite clear, this relative difference is destined to grow materially in our favor in the near future.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Skin Wool in Germany.—The German Credit Institute, of Saxony, has formed a joint stock company having for its object the production of skin wool, which has hitherto been produced almost exclusively in the south of France and Northern Italy, says Consul George Sawter, of Glauchau. Glovers' wool has been produced here only in limited quantities. The textile industries were compelled to cover their requirements in this line from abroad—i. e., from France and Italy.

This term does not refer to a new sort of wool, but applies to the raw products of animal wools hitherto known as "Raufwoolle" (scraped wool) or "Gerberwolle" (glovers' wool). Under "wool" is collectively understood the hairy covering of the various breeds of sheep, from which such wool is shorn during life. But, as one can hardly shear them down to absolute nakedness, a certain amount of wool, or hair, is left as a covering after shearing. The product so obtained is known as "glovers' wool." Now, the wool of slaughtered animals is mostly of inferior quality, and, moreover, materially shorter than that obtained by shearing the living animals, for which reason the former is used for making up inferior textiles, such as low class flannels, etc. Skin wool is wool which is scraped off of the skins of dead sheep. The wool obtained in this manner is, as a rule, longer, stouter, more healthy and uniform than that obtained by shearing, because sheepskins are mostly obtained from animals slaughtered for food, which must necessarily be sound, large, and healthy, whereas shorn wool is obtained as well from sickly, decrepit animals—such as are found in every flock. Skin wool is, consequently, likely to be more uniform in respect to fineness of quality, because, in scraping the wool off the skin, the coarser portions which grow on certain parts of the body can be sorted more carefully than is the case with shorn fleece.

Skin wool and glovers' wool are thoroughly different in character. The latter is principally removed from the skin by chemical means, and, in consequence, has not the same value as the shorn wool for the wool industries, more especially where it is a question of producing sensitive colors. Skin wool, on the other hand, is obtained without using chemicals and is fully equal to shorn wool in respect to quality and, indeed, for certain purposes—i. e., as abb wool (warp)—it is often preferred to shorn wool, owing to its tenacity and length. It is hardly necessary to specially mention that where skin wool is desired, the main thing is to allow the fleece to have had a growth of from eight to twelve months. As to the process of producing such skin wool and its commercial value, nothing whatever has been made public up to this time.

A New Electrolytic Process of Manufacturing Chemicals.—For some months past, there has been an increasing activity in the chemical trade of this district—the largest and most important of its kind in Great Britain—and quite recently an added impetus has been given by the establishment of works using a new electrolytic process, says Consul James Boyle, of Liverpool. Up to a few years ago, the chemical trade of this district was exceptionally prosperous; but now it has to meet German competition, and since the going into active operation of the present tariff, the exportations to the United States have tremendously decreased. During the fiscal year ended June 30, 1893, there were exported to the United States from this district alone chemicals to the value of $9,507,269. During the fiscal year ended June 30, 1899, the value was only $1,982,536. The trade appears to recognize that it can never recover the American market—at least not to the extent heretofore existing. The endeavor is to create new markets and to meet competition by more economical methods of manufacture.

There has just been started at Farnworth, near Liverpool, a new process of separating chlorine and sodium by the direct decomposition of salt by electrolysis, without the introduction of any other ingredient. It is called the Hargreaves-Bird process. The Liverpool Post gives the following explanation of the method:

"Salt is submitted to a suitable current of electricity, and both the substances are produced unmixed and pure. The salt used is in its cheapest form, being that of brine pumped up from its native bed, the salt of which—delivered into the actual apparatus of the factory—costs no more than about 3d. (6 cents) per ton, as against 7s. ($1.70), the usual price for the rough salt used in the older alkali works. The apparatus, or cell, in which this is effected is a narrow tank, the walls of which are porous. Brine is pumped into it, and on the passage of electricity a solution of soda flows slowly down from the outside of these wet walls, yielding at once soda crystals; while the chlorine in like automatic manner passes away for the production of bleaching powder, chlorate of potash, or such other chlorine compounds as may be required. No raging furnace, no sulphur kilns, nor the noxious fumes rising from such are present. No waste materials are produced, unless as such be reckoned the ashes from under the steam boilers which produce the motive power for the generation of the electric current. Even the smoke from the boiler fires and the waste steam from the engine are used in carbonating and dissolving the soda thus formed. In the actual production scarcely any hand labor is required. All moves on in silent regularity, and it is only in the necessary handling and packing up of the materials produced that labor comes in.

"One distinction of the cell is the peculiar diaphragm used. It is a sheet of asbestos composition, non-porous in the ordinary sense of the term, but when forming the walls of the cell, the contents of which are electrically excited, it allows molecules of sodium hydroxide to pass, but very little sodium chloride."

It is claimed that the above process is much more economical and simple than the former, including the rival electrolytic methods. It is stated that one difference between the Hargreaves-Bird process and the Kastner-Keller process (which has been in use in this district for some time) is that mercury is used in the latter process, but not in the former. Large sums of money have been spent in experiments with different electrolytic methods with varying success, and it is too early yet to say whether the new process will meet expectations. Speaking generally, however, the chemical trade of this district is now in a flourishing condition, and orders during the last month have been exceptionally large—mostly, however, for home consumption. Still, trade is not as good as it was ten years ago. Since the great decrease in shipments to the United States, continental orders have largely increased, in spite of German competition. Most of the new orders have been from Germany, Russia and France. Present prospects are good.

The salt trade is naturally closely allied with the chemical trade. Strange to say, however, the salt trade has not followed the chemical trade in a resumption of comparative prosperity. For months past, attempts have been made to form a combination of all the salt companies of Great Britain, most of them being in this neighborhood, on the Cheshire side of the Mersey. The combination was effected recently at a meeting of the trade in Liverpool, and the announcement is officially made that there will be an advance in prices from the present date. It is not proposed to consolidate the many individual companies into one gigantic "trust," to be operated by one executive, with a "pooling" of the profits and losses; but the arrangement is to form an agreement to regulate and limit the output of each concern and to keep prices up to a certain point, each company, however, to retain its own separate organization, both as to management and profits and losses.

Export of Watches to Russia.—Vice-Consul-General Hanauer writes from Frankfort, November 18, 1899:

During late years, Warsaw has become the center of the watch trade in Russia. The dealings between foreign and Russian merchants are consummated there, these parties meeting once a year for the transaction of business in this line. At this time, the Russian buyers from Moscow, Tula, Saratow, and Siberia give orders for the next twelve months and settle for past purchases. This trade is quite important. A few Geneva watch-making firms sell over 1,000,000 rubles' worth here annually. Swiss watch manufacturers purpose now to establish an extensive depot of goods in their line at Warsaw, to increase the sales and monopolize the Russian watch market. They have applied to the Swiss consul in Warsaw to furnish them detailed information. Our export associations would do well to obtain similar data from our consuls.

Beet Harvest in Russia in 1899.—Consul-General Holloway, of St. Petersburg, on November 22, 1899, writes:

The department of unassessed taxes and government sale of liquors has compiled a preliminary statement concerning the outlook for the beet harvest and its quality in 1899, based on information furnished September 1-13, 1899, by the excise collectors, which places the harvest of beets in European Russia during the present year at 7,026,513 tons, against 6,182,394 tons in 1898. Of that amount, the southwestern region will furnish 3,918,173 tons; the central, 2,267,218 tons; and the Vistula region, 841,122 tons. An increase of 13·7 per cent. is expected. In the southwestern region,

12·8 per cent.; in the central, 18·6 per cent.; and in the Vistula, 5·7 per cent. The average harvest per acre in European Russia amounted to 7 tons, against 6 tons in 1898. The quality of this year's crop is below that of last year in three-fourths of the area in beet roots.

Household Schools in Liege.—Consul Winslow sends the following from Liege, November 27, 1899:

There are in the city of Liege ten free household schools, five of which were founded in 1890 and the others in 1898. Nine of these are evening schools, lasting two hours on four nights of each week during the school year. These evening schools are attended by girls from 12 to 13 years of age who have finished their elementary course in the day schools.

One day school is attended by the girls of the sixth school year in the public schools, divided into groups of twenty-four, each group attending a week at a time. Each group forms four divisions of six pupils each, who undertake the different tasks, such as cooking, mending, washing, etc. The authorities intend to open three more day schools during the school year 1899–1900. There is talk of connecting a household school with each elementary school.

The branches taught in these schools are cooking, washing, mending, hygiene, household economy, and, in fact, everything relating to housekeeping. Of late, the care of little children has been added. These schools are founded and maintained by the city, with the aid of government, which pays from 40 to 60 per cent. of the expense. The term lasts from the 1st of October until Easter, when the pupil gets a diploma. From Easter to the last of July the courses are attended by the higher classes for four weeks—a week at a time, in order not to interfere with their ordinary studies.

Phylloxera in Cape Colony.—Consul-General Stowe writes from Cape Town, November 2, 1899:

The parliament of this colony has issued a paper showing that the amount of compensation paid for the destruction of vineyards on account of phylloxera has been $97,845.85. The amount paid for inspection of vineyards and attempted destruction of phylloxera has been $301,679.20, and the amount spent on the introduction of American vines and all subsequent expenses connected therewith, $431,867.81. It has been found that American vines transplanted into the soil of this country are free from the ravages of phylloxera. Over $35,000 has been spent in assistance to grape growers and for premiums on "fruit grown on American vines." On native vines various compounds, in which sulphate of copper is an ingredient, have been used, but with little success. I am pleased to see, however, that "Knapsack" and "Bucket" and "Barrel" spray pumps manufactured in Ashland and Salem, Ohio, are being introduced for spraying vines and fruit trees, and have met with success. The demand is bound to increase, as spraying will become more necessary and general. The diseases of fruit trees in South Africa are caused by bacteria, by fungi, and by insects.

Opening for American Coal in Canary Islands.—Consul Berliner writes from Teneriffe, December 9, 1899:

There is a very good opening for Pocahontas coal here at the present time. The ruling price of Welsh coal for the coming year seems to be 16s. ($3.89) per ton, which, with freight from 8s. 6d. to 9s. 6d. ($2.07 to $2.31) per ton from Cardiff, would bring the total cost to about $6 per ton delivered here. More than 200 steamers at Las Palmas and 162 at Teneriffe took coal during November, 1899. Many of these received only half of what they desired, and a number got none at all, as the supply was not sufficient. In conversation with dealers and steamboat captains and engineers, I find that many prefer the Pocahontas coal to the Welsh, and I have no doubt a very profitable trade in this fuel could be established.

American Goods in the Straits Settlements.—Consul-General Moseley, of Singapore, under date of November 9, 1899, states that Messrs. Katz Brothers have introduced American lard into that market and are selling it in 10-pound tins at 24 cents a pound—quite a large reduction from the usual retail price. The same firm has also received, in the last few days, a large stock of assorted canned American fruits, vegetables, and meats; also American buggies. Mr. Moseley adds:

I am doing all I can to have American goods brought into this market. Our manufacturers of bicycles are represented here by active traveling men, who are placing the wheels in every city and town and village in this section. If other American houses will display the same energy, the trade of the United States here will be largely increased.

German-South American Steamship Service.—Under date of November 17, 1899, Consul Caples, of Valparaiso, informs the department that the Kosmos German Steamship Company will hereafter dispatch a steamer from Hamburg and Antwerp monthly to San Francisco, Cal., touching, among other ports in Europe and on the east coast of South America, at Valparaiso, Iquique, Callao, Guayaquil, Corinto, La Libertad, Acajutla, San José de Guatemala, Champerico, and probably at other intermediate ports, carrying passengers and freight.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 628, January 15.—*German Echoes of the Commercial Exposition—Failure of Olive Crop in Southern Europe.

No. 629, January 16.—*American Furniture for South Germany—Wool Products of Uruguay—Steamship Lines to Rotterdam—American Trade in Syria.

No. 630, January 17.—Commercial and Industrial Affairs in Siberia.

No. 631, January 18.—Germany's Carrying Trade with German East Africa—German Vintage of 1899—River Improvements in Winnipeg.

No. 632, January 19.—*Exports of German and American Bicycles—Notes from Dawson City—New Ballast Regulations at Newcastle, New South Wales—Coal in Germany: Correction—Decrease in German Exports to the United States.

No. 633, January 20.—Economic Conditions in Haiti—The Cape Nome Gold Fields.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Iron Enamel.—Melt together 10 parts of crystal glass, 1 of sodium carbonate, and 1 of boracic acid, cool off and powder. The article to be enameled must be carefully cleaned in diluted acid, dried, next lightly coated with gum Arabic solution and sprinkled with the above named powder. This is best done by sifting through silk. Next the article is heated to a redness, and as soon as the powder has dried completely, is taken out and cooled off in a moderately warm place free from draught. If the coating is incomplete, a second one may be applied.—Journal der Goldschmiedekunst.

Smoking Color for Sausages.—A red dye already much employed for raw and boiled sausages imparts to the sausages boiled in or laid into its aqueous solution a handsome, uniform reddish-brown color, which only adheres externally to the gut. Too large an admixture causes an orange, varnish-like coloring. The dyestuff is orange II., the sodium salt of sulphanilic-acid-azonaphthol. It is soluble in water, but insoluble in alcohol and petroleum ether. The aqueous solution gives, with sulphuric acid, a brownish yellow precipitate. With soda lye a dark brown deposit results; with concentrated sulphuric acid, a fuchsine red solution; upon addition of water, a brownish yellow deposit. Wool is dyed orange with aqueous solution. The color was found to be perfectly harmless by an experiment on animals.—Zeitschrift für Untersuchung der Nahrungs und Genussmittel.

Liquid and Glossy Shoe Dressing.—For the production of this liquid and lustrous polish, dissolve 6 kilos. of gum arabic and 0·12 kilo. of gilding size in 12 kilos. of water.

Solution accomplished, add 0·15 kilo. of nigrosine, soluble in water, 0·7 kilo. of glycerine and 0·1 kilo. of oleine—stearine oil—and scent the well mixed mass with 24 grammes of pear oil. Finally add 5 grammes of salicylic acid and fill the preparation after having been mixed again, into bottles.

By boiling down, the polish may also be sold in the shape of cream or paste.

The advantages offered by this new liquid polish are that a very handsome luster is obtained without brushing; besides, the leather is rendered very pliable and durable by it, which is caused by the large admixture of glycerine. The new polish is so composed that it will impart a hitherto unattained luster even to greasy and oiled shoes. It may be employed for black and for tan leather. In the latter case, a yellow aniline color is used instead of the nigrosine.—Neueste Erfindungen und Erfahrungen.

Contributions to the Study of the Chemical Nature of Wood. By Vittorio Flick.—If wool is treated, in the dark, with nitrous acid in the shape of sodium nitrite, it acquires a vivid yellow coloring and exhibits an increase of the affinity for basic dyestuffs and a decrease for the acid dyestuffs. These new properties, however, quickly disappear again in the light, even in diffused light, and a quarter of an hour's action suffices to decolorize the wool almost entirely. But, if the wool treated with nitrous acid is, during or previous to the action of the light, brought into contact with a liquid or with acid vapors, the bright yellow shade is increased to orange and the wool retains this new coloring.

The author makes practical use of this. A ground with thickened sodium nitrite is printed on pieces which have previously been foularded with tartaric acid, and the last dye is given with a basic dyestuff. The pattern printed with the nitrite stands out in a dark color.

The wool changed by the nitrous acid also possesses the quality of uniting with certain aromatic oxy-derivatives and to give colored compounds with them. Those dyestuffs which are combined with resorcin, orcin, pyrogallol, phloroglucin and β-naphthol, are very unstable, but by a treatment with metallic salts they obtain greater strength. The author concludes, in concord with Prudhomme, that the wool is not diazotized but nitrosized and hopes to soon be able to give fresh proofs for this.—Färber Zeitung.

Bleaching of Cotton.—The late Horace Koechlin deposited with the Société Industrielle de Mulhouse several sealed letters on bleaching, which have now been opened.

1. Bleaching by Steaming.—The singed and washed cotton goods are passed through hydrochloric acid of 2° Bé. Leave them lie in heaps during one hour, wash, pass through sodium hypochlorite of 10° Bé. diluted with ten times the volume of water. Let the pieces lie in heaps for one hour, wash, pass through caustic soda lye of 38° Bé. diluted with eight times its volume of water, steam, put again through sodium chloride, wash, acidulate slightly with hydrochloric acid, wash and dry. Should the whiteness not be sufficient, one may repeat all the operations.

2. Bleaching with Calcium Sulphite.—The cotton goods are impregnated with 1 liter of water, 1,000 grammes of caustic lime and 500 grammes of bisulphite of 40° Bé.; next steamed during 1–2 hours at a pressure of 1–2 atmospheres, washed, acidulated, washed and dried. The result is just as white a fabric as by the old method with caustic lime, soda and calcium chloride. The bisulphite may also be replaced by calcium hydrosulphite, and, instead of steaming, the fabric may be boiled for several hours with calcium sulphite.

3. Bleaching of Vegetable Fibers with Hydric Peroxide.—I pass the pieces through a solution containing caustic soda, soap, hydro-peroxide and burnt magnesia. The pieces are piled in heaps on carriages; the latter are shoved into the well-known apparatus of Mather & Platt (kier), and the liquid is pumped on for 6 hours, at a pressure of two-thirds atmosphere. Next wash, acidulate, wash and dry. The bleaching may also be done on an ordinary reeling vat. For five pieces are needed about 1,000 liters of water, 10 kilos. of solid caustic soda, 1 kilo. of burnt magnesia, 30 liters of hydric peroxide. After 3-4 hours' boiling, wash, acidulate, wash and dry. The bleaching may also be performed by passing through barium peroxide, then through sulphuric acid or hydrochloric acid and next through soda lye. One may also commence with the latter and finally give a treatment with hydric peroxide.

The whiteness obtained by the above process is handsomer than that produced by the old method with hypochlorites, and the fabric is weakened to a less extent.—Leipziger Färber und Zeugdrucker Zeitung.

SELECTED FORMULÆ.

Toning Solutions.—

DR. LIESEGANG'S TONING BATHS.

1. Phosphate of sodium ..... 15 grammes.
   Chloride of gold ..... 1 "
   Water ..... 1 liter.

2. Chloride of gold ..... 1 gramme.
   Carbonate of sodium ..... 15 "
   Chalk ..... 5 "
   Water ..... 1 liter.

After 12 hours the bath is perfectly clear and colorless, when it is ready for use. It is very durable, and gives fine tones.—Pharmaceutical Era.

Grease and Paint Remover—Ink Eraser.—For a spot and grease remover try the following paste:

Benzol	500 parts.
Benzin	500 "
Soap, best white, shaved	5 "
Water, warm, sufficient.	

Dissolve the soap in the warm water, using from 50 to 60 parts. Mix the benzol and benzin, and add the soap solution, a little at a time, shaking up well after each addition. If the mixture is slow in emulsifying, add at one time from 50 to 100 parts warm water, and shake violently. Set the emulsion to one side for a few days, or until it separates, then decant the superfluous water, and pour the residual pasty mass, after stirring it up well, into suitable boxes. Another preparation, a liquid which is a great seller when properly handled, is as follows:

Benzol (not benzin)	89 parts.
Acetic ether	10 "
Valerioamylic ether	1 "

Mix. The valerioamylic ether is commonly known as artificial essence of pears, and, besides having a solvent action on greases, imparts to the mixture a pleasant fruity odor. Finally, the following makes a ready seller. It was formerly hawked around the streets under the name of "Lightning Grease Eradicator":

Curd soap	3 parts.
Sodium carbonate, commercial	2 "
Borax	1 "
Water of ammonia, stronger	16 "
Alcohol	3 "
Sulphuric ether	4 "
Water	86 "

Shred the soap and dissolve in a portion of the water by the aid of heat, and in the solution dissolve the borax and sodium carbonate. Add the alcohol and the ether, and agitate until thoroughly incorporated, then add the remainder of the water, a little at a time, under constant agitation.

INK ERASERS.

The following makes a good "two solution" ink remover:

Solution A.

Citric acid	1 part.
Concentrated borax solution	2 "
Distilled water	16 "

Dissolve the acid in the water, add the borax solution, and mix by agitation.

Solution B.

Calcium chloride	3 parts.
Concentrated borax solution	2 "
Water	16 "

Add the calcium chloride to the water, shake well, and set aside for a week, at the expiration of which time decant the clear liquid, and to it add the borax solution. Directions for use: Saturate the spot with Solution A, apply a blotter to take off excess of liquid, then apply Solution B. When the stain has disappeared, apply the blotter, and wet the spot with clean water. Absorb this with a blotter and repeat, applying water two or three times (to remove residual chemicals), finally dry between two sheets of blotting paper. Spots removed by this agent never return, and cannot even be brought back by the use of chemicals. Another formula, a most excellent one, and one that few inks can resist, is as follows:

A. Mix, in equal parts, potassium chloride, potassium hypochlorite, and oil of peppermint. B. Sodium chloride, hydrochloric acid and water, in equal parts.

To use: Wet the spot with A, let dry, then pencil it over lightly with B, and rinse in clear water.

A good single mixture, which will answer for most inks, is made by mixing citric acid and alum in equal parts. If desired to vend in a liquid form, add an equal part of water. In use, the powder is spread well over the spot and (if on cloth or woven fabrics) well rubbed in with the fingers. A few drops of water are then added, and also rubbed in. A final rinsing with water completes the process.—National Druggist.

A Rival to Celluloid.—Nitrated cellulose has long held the field as the basis of a flexible glass, as celluloid has been called; but there seems a probability that before long Messrs. Cross and Bevan's invention, aceto-cellulose, may be found a formidable rival, for it possesses many advantages over the pyroxylin which, in combination with camphor, is the main constituent of celluloid. . . . Perhaps the most conspicuous quality of the acetate compared with the nitrate is its non-inflammability—it burns very imperfectly. It differs further from the latter in that it is insoluble in methylic and ethylic alcohols, acetates of amyl and ethyl, acetone and ether, but is soluble in benzoate of ethyl, chloroform, epichlorhydrine, acetic anhydride, glacial acetic acid, and nitro-benzine, the solution in the latter becoming a solid, completely transparent jelly. The solution in the other named liquids can be diluted with acetone without precipitation taking place. The aceto-cellulose resists most reagents in a remarkable manner. Dilute acids and alkaline lyes destroy nitrocellulose; but, with the exception of dilute nitric acid, do not act upon the new substance, in some cases even when boiling. It is probable, too, that, used as a basis for films, it will be possible to dry them quickly by the aid of alcohol in the usual manner, a process quite out of question with celluloid, as any one knows to his sorrow who has tried it.—British Journal of Photography.

KAMERUN—THE LAND AND THE PEOPLE.*

THE steamer which sails from Lagos past the misty cliffs of Kamerun, through the Bight of Biafra, lands at Kribi, which is the capital of the district including the stretch of coast between the Nyong and Campo Rivers. The land about the mouths of these streams is flat and sandy. Huge rocks are scattered along the coast, many of them polished smoothly by the surf. The forest extends to the very shore; for the trees are protected by the rocks and flourish as vigorously as if they were growing far inland. But sometimes the roots have been undermined by the sea; and the road from the Nyong to Longji, from the Campo to Itunde, is strewn with fallen trees.

Wherever the foot-hills of the mountain-range extend to the sea, small, sheltered bays are found. The natives of the coast have settled here, at the mouth of a mountain stream; for the coves and the bays enable them to land safely and protect their frail canoes; in the streams are crabs—excellent bait for deep-sea fish. The whites have also taken advantage of these natural conditions and have built factories which have become the centers of an extensive caravan trade. Thus it was that the factories of Klein Batanga, Longji, Plantation, Kribi, Gross Batanga, and Campo were established. The southern part of Kamerun exports far the greater quantity of ivory and crude rubber produced along the coast. The constantly increasing demand for rubber has caused the settlers to penetrate further and further inland. Since there are no transportation facilities whatever, a single firm very often employs as many as 2,000 porters to carry rubber and ivory. Barter is still the only form of commerce known. Often a factory will establish bush-factories in good districts, place a white merchant or a black trader in charge of each, provide him with goods, and receive in exchange the products which he has procured in the interior.

In the center of the southern district lies Kribi, the most important station of Kamerun. Here are located the governor's seat, tax-offices, post-office, a house for transient officials and a mission-house. The governor besides ruling the coast district must see to it that the interior stations—Jaunde and Lolodorf—are provided with money, provisions, and articles of exchange. The central station serves as a supply depot for the other stations, and as the starting point of all expeditions sent out by the home government.

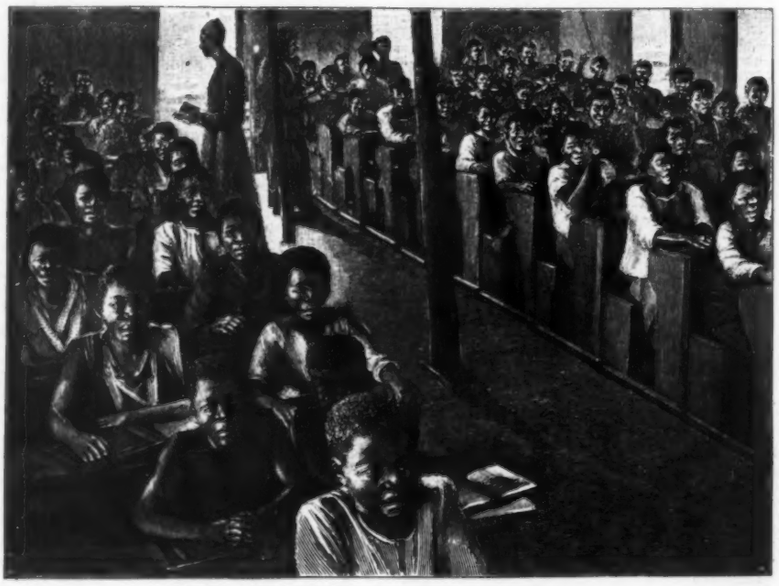
A GROUP OF KRIBI CHILDREN.

The mission, ever since its establishment in 1892, has done much good educational and religious work. Beginning with a single dwelling house and church, it now includes several goodly-sized buildings, among which may be mentioned a large dormitory with accommodations for eighty Mabea, Jaunde and Kribi boys, a large, well-lighted, well-ventilated school, and a workshop in which boys receive manual training. The pupils are not only educated, but also supported gratuitously. In a large garden, European vegetables are cultivated and experiments made with exotic useful and ornamental plants. About three-fourths of a mile from the central mission, and separated therefrom by the native village, was a house in which three white sisters brought up orphan children and taught native girls domestic duties.

The inhabitants of this southern district are composed of Batangas, Mabeas, Bulis, Ngumbas, Jaundes, and Banes. The Batangas are hereditary inebriates, degenerated by decades of alcoholic indulgence, and live chiefly by fishing and barter. Parallel to the coast, about one hour's journey inland, are the settlements of the Mabeas, from whom the larger portion of the caravan porters are recruited. Before trade developed to its present proportions, they were excellent hunters. Some of them have not lost their old-time skill, and still hunt with their peculiar nets and specially trained dogs. In the movement of the tribes from the interior to the coast, the Mabeas have resisted the horde of Bulis. Sometimes the Mabeas were compelled to flee to the sea and take refuge in the settlements of the whites.

The Bulis, forming part of the racial stock of the M'pangues or Fan, inhabit the region between the Kribi and Campo Rivers. They never unite in large communities, but live in scattered villages under the rule of a chief. Constant feuds among themselves, wars with their neighbors, the Ngumbas and Mabeas, and the dangers of their native forests, have made them an arrogant, violent race, cunning and thievish. Their boldness and treachery are proved by their frequent robberies of caravans sent to Buli, and above all by their recent attack on Kribi.

It may have been that the long absence of the troops at Tibati induced the Bulis to conclude that the soldiers had probably all been killed. At all events, on the 25th of September they attacked the mission house of Kribi, after they had pillaged and destroyed the house of the three sisters on the previous day. Like the leopards of their native forest, they crept forward. At least five hundred of these black demons surrounded the mission. In front of the buildings a thin line of whites and blacks confronted them. The struggle was short and decisive; the defenders of the mission were compelled to fall back, for their opponents were too numerous. While the mission-house garrison were firing the last shot, the government steamer "Nachtigal" appeared on the scene and relieved them from their straits. The German government will probably take the necessary steps to discourage the Bulis from similar onslaughts.



CLASSROOM IN THE MISSION SCHOOL.

THE MISSION CHURCH, SCHOOL AND DWELLING HOUSES.

* From the Illustrirte Zeitung.

THE GREAT SILK INDUSTRY OF THE UNITED STATES.

ONE of the most interesting features of the industrial development in the United States during the last generation has been the growth of the manufacture of silk goods. Forty years ago this country imported 87 per cent. of all the silk goods used in the country. To-day, with a vast addition to the demand due to growth of population and wealth, the country is importing only 15 per cent. of the silk goods it consumes and has become the greatest manufacturer of silk goods in the world. In addition, this country has wrested from Europe and Asia the supremacy which they once possessed in this industry. Within the recollection of men of only middle age, the people of the United States were almost wholly dependent upon Europe for every article of wear of which silk was the principal component part. To-day this country supplies its entire market with everything in silk goods except the finest products of the hand looms of Lyons, Crefeld and Zurich. The prospect is that within a few years importations from these centers will be too small to be

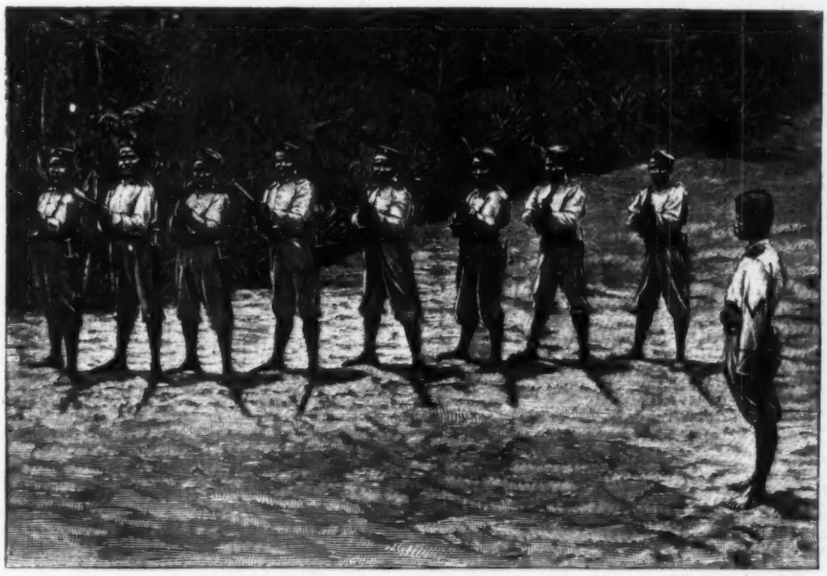
considered from a commercial point of view except as among the curiosities of trade statistics.

The day of Europe in the American silk market is over, and the only competition which it is believed Americans still have to fear is that of the Orient, where in China and Japan the open-door policy is leading to the introduction of modern machinery and methods, which, added to cheap labor, may yet make them dangerous rivals in this and other industrial fields. While the silk manufacturing industry in America has had many ups and downs, so far as its profitable condition is concerned, its growth since 1860 has been on the whole constant, representing, decade by decade, just about the natural increase in the country's consumption of such goods and keeping the importations down to figures which have varied little from constant quantities. Within the last few years the business has taken a firmer grip, and now shows a strong tendency to wipe out the importation figures altogether.

The trend of progress by our silk manufacturers is shown in the following figures: In 1860 we made only 13 per cent. of the silk goods consumed in the country; in 1870 we had advanced to 23 per cent.; in 1880, to 38 per cent.; in 1890, to 55 per cent.; and in 1898, to 85 per cent. This year it is believed that the tables will be completely turned about and that only the 13 per cent., which we made ourselves in 1860, will be sent to us from all the rest of the world. While we have thus been superseding Europe in supplying ourselves with silks and satins, velvets and all the other luxurious and useful products of silk, our importations of the raw product of the silk worm have as steadily increased until to-day we are using fully one-third of the entire world's product of marketable silk. In this regard our beginnings were most modest. As lately as 1875 we imported only 1,101,681 pounds of raw silk and 5,737 pounds of spun silk, worth altogether about $4,525,000, while for the year ending June 1, 1899, the imports of raw and spun silk were 6,297 bales, containing more than 10,500,000 pounds and valued at $32,735,464. The growth of the importations of raw silk has been constant on the whole, although one can detect in the tables giving the yearly returns evidences of the industrial and financial troubles which the country has been through in that time. In 1877 and 1878 the importations of raw silk were something like 160,000 pounds less than in 1876. The value of the silk in 1877 was about $1,500,000 less than in 1876 or 1878. Again, in 1891 the importation fell off from 5,943,360 pounds in 1890 to 4,917,688 pounds, and in 1894 it dropped to 4,956,875, after having been up to the 7,500,000 mark for both 1892-93. In 1896 it jumped to 8,000,631 pounds, and fell again in 1897 to 6,513,612 pounds to average up. In 1898 it reached 10,315,162 pounds. Prices, too, have had considerable to do with these fluctuations, having varied from $1.87 a pound for raw Canton silk to about $6.

The raw silk comes from France, Italy, Austria, Spain, China, Japan, India, and the Levant. Excluding the amount used at home in China and Japan, of which there is no record obtainable, the world's production of raw silk last year was 34,063,274 pounds, and this year it is estimated that it will reach nearly 36,000,000 pounds. Of this, China produces both the largest amount of any one country and the best quality. In all the other countries the worms in the cocoons are killed by roasting before the silk is wound off, and this reduces the luster of the filament, but in China the filament is reeled off while the worms are still alive. This practice militates, however, against the quality of the silk in another way. The reeling is done at the homes of the silk raisers and is of very uneven quality. Most of this silk has to be rereeled before it can be marketed. China sends into the markets about 16,700,000 pounds of raw silk. Japan comes next with 7,250,000 pounds, and Italy a close third with 6,250,000 pounds. France produces about 1,400,000 pounds, Austria 520,000, Spain 175,000, India 650,000, and the Levant 2,350,000 pounds.

The firm establishment of silk manufacturing dates from 1860, when French silks were admitted into the English markets free of duty. A great silk industry had grown up in England previous to that date, and we drew our supplies of these goods in about equal quantities from England and France. With French goods admitted free, the English silk throwers and weavers were forced out of their own markets, and many of them came to this country, bringing with them their machinery and hands. They found Paterson, N. J., the most desirable place in which to settle, and here they built up their industry. Paterson was already the home of the Pioneer Silk Company's mills, started in 1840 by John Ryle, and this was the first enterprise of the kind begun in America which was destined to live. In 1855 Hamil & Booth built a second silk mill in Paterson, and these two, with a few others, were the nucleus around which the influx of Englishmen gathered.



A COMPANY OF NATIVE POLICEMEN.

NATIVES DANCING.

There had been no lack of attempts to establish the silk industry in this country in all branches, from the growing of the silk worms to the making of finished goods. These attempts had been encouraged by the crown and state from the time of the earlier settlements, and had resulted in great industrial crazes at times, but in nothing more permanent except the establishment of a number of factories where sewing silk and trimmings were made. Many of these survive and were doing business when the English weavers came over in 1860.

In 1815 a silk trimming factory was established in Philadelphia. A ribbon factory was started in Baltimore in 1829. In 1834 dress trimmings were made in Boston. Sewing silk was made at Florence, Mass., and at Dedham, Mass., in 1835, and these industries had spread until in 1860 New York had forty-four little establishments of one kind or another which employed 1,159 hands and produced $1,154,294 worth of goods. Pennsylvania at that time had thirty-five factories employing 1,559 hands and turning out $1,767,845 worth of goods. Connecticut had twenty-two factories employing 1,137 hands and producing $1,301,400 of goods; Massachusetts, 20, with 781 hands and a product of $1,297,050; New Jersey, 9, employing 716 hands and producing $968,700 worth of goods. In 1870 New Jersey's mills had increased to 28, with 2,790 hands and nearly $4,000,000 production. In 1880 they had increased to 106 factories, with nearly $13,000,000 production, and in 1890 to 132 factories, with nearly $31,000,000 production. In this same year New York had 185 mills and employed 13,000 hands, but produced only $19,400,000 worth, while Pennsylvania produced about the same amount in sixty-six mills, with 9,500 hands. Connecticut's product had risen to $9,800,000 from thirty-five

A VILLAGE STREET.

mills, and Massachusetts to $5,500,000 from twenty mills.

Ribbon weaving for many years was the staple work of the Paterson mills. This had been encouraged by the largest silk importing houses, which found an advantage in ordering ribbons of mills right at hand instead of waiting for orders to be filled from Europe. The duty of 50 per cent. or more was always enough to secure a profitable market for the home product. Ribbon weaving required expert men at the looms, and these men received high wages. The minimum of earnings for these men was $20 a week and more of them received $40 a week, while the bulk of the help, made up mostly of girls, received so little that the whole average of wages in the silk mills of Paterson in 1880 was only $1 a day, while $3 was the average paid in the locomotive works, the other great industry of that city.

The Weavers' Guild was powerful in those days and it was the arbitrary action of this body which finally started the scattering of the silk weaving mills into other parts of the country and particularly into Pennsylvania. The first of the Paterson manufacturers to build elsewhere was the Phœnix Manufacturing Company, which put up the Adelaide Mills at Allentown, Pa., in 1881. A few years later, during a long strike, when the strikers dynamited the home of William Strange, one of the pioneer manufacturers of Paterson, the tendency to go elsewhere to escape such troubles was accentuated, and then began the silk-making boom in Pennsylvania. As the manufacturers looked over that State they found it offered many advantages. Silk and its products are light and freights, therefore, are not of the importance that they are with cotton or wool mills, while throughout Pennsylvania were found scores of towns where the cost of coal was less than $1 a ton, where the local authorities were glad to remit taxes for many years on the mill properties and where there was an abundant supply of the cheap labor which is a necessity of the silk industry. To-day, of the 861 establishments in the country, New Jersey has 257, New York 228 and Pennsylvania 172, but in the list of looms and spindles required for the equipment of new mills in 1898 Pennsylvania led with 1,255 looms out of a total of 2,340 and 37,000 spindles out of a total of 53,000, and there are silk factories in more than fifty Pennsylvania towns, including Allentown, Alburtis, Altoona, Avoca, Bethlehem, Bath, Bloomsburg, Carlisle, Catasauqua, Columbia, Carbondale, Darby, Danville, Easton, Emaus, Ephrata, Eden, East Greenville, Fleetwood, Freeland, Harrisburg, Hawley, Honesdale, Hanover, Hallstead, Lancaster, Leighton, Marietta, Mauch Chunk, New Holland, Newberry, Philadelphia, Plymouth, Pottstown, Pottsville, Reading, Rockledge, Scranton, Sunbury, Stroudsburg, Taylor, Titusville, Williamsport, Weatherly and Wilkes-Barre.

Another field where silk manufacturing may become an important industry is just being exploited by a New York house. Within a month or two a mill has been put in operation in Fayetteville, N. C., by the Ashley & Bailey Manufacturing Company, in which it is their intention to use young negro labor exclusively. The mill has been provided with competent teachers and already from 75 to 100 hands are at work, led by the first pupil, a young negro preacher. The projectors of the enterprise believe that the young people of the negro race are well adapted to acquiring the manual dexterity needed for silk handling, and if this proves true they will go on and build other mills as hands become available. The present mill will employ 350 hands and will do spinning and broad silk weaving.

It is probable that in the future, at least until some great revolution is made in machinery for dealing with silk filaments, the best interests of the silk manufacturers and of the country will be served by scattering the mills about in many places, rather than concentrating the industry. In this way employment will be given to the surplus labor of the community, and especially to lads and lasses, who make the most valuable operators because of their deftness of touch, and even the low wages which silk making pays will be a blessing to the people. These wages, according to a table in a recent report on the industry in Pennsylvania, are an average of $1.21 a day for males and 70 cents a day for females in a list which shows the earnings of operatives in all occupations in the State—in which the highest wages are for steam pump makers at $2.44 a day and the lowest are for the female silk workers at 70 cents.

Silk, from the first branch of its production, is essentially prodigal of labor and an article of luxury. It is declared by an expert that it takes more time to build a spool of silk twist than it does to build a modern locomotive, and during much of this time some one's hands must be employed in the operations. It is the amount of time used in raising and tending the silk worms and in reeling off the filaments of the cocoons that has defeated each attempt to introduce silk raising as an industry in this country and will probably continue to defeat its successful introduction.

Every once in a while stories describing the enormous profits to be derived from silk worm raising gain currency. One has recently been going the rounds about a planter near Charleston, S. C., who has an annual income of $6,000 to $8,000 from this source and has instructed his neighbors in the art, and now a number of these neighbors are adding $800 or $1,000 a year to their incomes by silk raising without interfering in any way with their regular plantation work.

Lest this should start a new silk worm craze, it may be well to call attention to the experiments in this direction that were undertaken by our forefathers, when land and labor were cheaper than they are to-day and the art of silk worm raising was just as it is now. Silk worm culture was begun in Virginia as early as 1619, and the planting of mulberry trees was required under penalty, by an act of the Colonial Legislature of 1623, while a bounty of fifty pounds of tobacco was offered for every pound of reeled silk produced. In 1656 the Virginia Colonial Assembly passed an act imposing a fine of ten pounds of tobacco upon any planter who had not at least ten mulberry trees on his plantation to each one hundred acres of land. In 1657 a reward of 10,000 pounds of tobacco was offered to any one exporting £200 worth of raw silk, but there is no record of any one having claimed it. In Georgia and in the Carolinas similar efforts were made to encourage silk raising all through the eighteenth century, but with no practical result, although a filature was built at Savannah in 1749 and Italian operatives were brought to the country to teach the art of silk reeling. The greatest amount of raw silk that there is any record of being raised was in 1759, when 10,000 pounds were produced in the cocoon, equal to about 1,000 of reeled silk. Bounties were as high as 3s. 6d. a pound for cocoons, or two or three times their market value, but the industry fell off rapidly until it disappeared.

The greatest silk craze that the country ever had was started in 1831 by a manual of silk culture prepared for the Masachusetts Legislature by Jonathan A. Cobb. Companies were formed all over the country to raise and manufacture silk. Mulberry trees were planted in every region, and there was hardly a household in which some silk worms were not hatched and fed. The price of mulberry slips rose and rose until it is recorded that at an auction sale of rooted slips twelve inches or more long, held at Germantown, Pa., on September 18, 1839, 260,000 slips were sold for $81,217.75 and a lot of 22,000 mulberry switches from 6 to 8 feet long was calculated to be worth $45,000 or at the rate of 2½ cents for each bud on them. The bubble burst at the end of 1839, and in 1844 a blight which fell upon the mulberry trees ended the craze entirely, but at this day mulberry trees may be found in every part of the older States, remnants of that time. Efforts have been made to revive the industry since, especially in California and Kansas, and in 1882 a silk dress made from the product of fourteen States was presented to President Garfield's widow by the Woman's Silk Culture Association of the United States, but the work has again fallen into desuetude.

The form in which the raw silk reaches this country is in hanks or twists of the filament as it has been reeled from the cocoons. Each thread of these skeins is composed of five of the original filaments, cemented into one by the hardening of the gummy envelope of the filaments after these leave the basins of warm water in which the cocoons are put to be unwound. The preparation of this silk for the loom is called throwing, and this consists of about a dozen distinct operations. The first of these is putting the twist of raw silk on a reel and winding it off upon spools turn by turn. Then comes the combining and twisting of the filaments into threads of various kinds, known as "singles," "tram," and "organzine." An idea of the intricacy and labor involved in just this part of the operation may be gathered from the fact that a thread of ordinary sewing silk contains about two hundred filaments of the silk as the worm spun it. Every part of these operations must either be done by hand or watched continuously, for the silk thread is built up entirely of continuous filaments.

Although the silk throwing, spinning, and weaving mills form the foundation of the industry in this country, and their products for the year will probably amount to $100,000,000 or more, this is by no means the whole of the benefit which the country derives from them nor the extent to which they give occupation to workmen or capital. Around this central industry cluster those of the dyer, printer, and finisher, the makers of machinery, the dealers in raw silk, and in the manufactured goods and many cognate businesses. How much these all represent in capital and hands employed it would be difficult to estimate, but in the various direct industries of producing ribbons, broad goods, sewing silks and twist, tie silks, hat bands, knit goods and laces, fringes, braids and trimmings, something like $120,000,000 is now invested and close to one hundred thousand hands are employed. Roughly speaking, about 50 per cent. in value of the silk product is in broad goods, 25 per cent. in ribbons, and perhaps 10 per cent. in sewing machine silks and twists, leaving 15 per cent. for the varied products of the other factories.

Many attempts have been made to supersede the product of the silk worm for textile use, but as yet none has succeeded, although artificial silks of several kinds have recently obtained a fair hold as a commercial product. The first attempt in this direction was in cultivating spiders as a rival to the silk worm. Queen Cleopatra is said to have had a robe of spiders' silk that could be drawn through a finger ring, but she was not noted for wearing much clothing. M. Cachot, a Frenchman, has recently succeeded in getting a considerable product of spider silk, by petting the spiders and reeling off their thread slowly, but there is no prospect that his system will become of any importance. The artificial silks are made of wood fiber, reduced to cellulose by the action of acids. This is dissolved to a glue-like consistency, forced through holes in glass and drawn out into threads which dry and harden in the air just as those of the silk worm or spider do. In fact, the material of this thread is identical with that produced by the spider and silkworm, and the fabric produced from it has the same qualities except that it is more harsh and does not wear so well. A cheaper substitute for silk is made of glue or gelatine drawn into threads in a similar manner, but this could never rank as anything but an imitation of silk.

Another imitation of silk is mercerized cotton, which is now finding its way into many uses. The process of giving to cotton a luster like silk and also adding much to its strength and wearing qualities, was invented by John Mercer, an English weaver. The cotton is treated, either in the yarn or piece, with caustic soda, and stretched if a luster is wanted, and the effect of the treatment is to change the fiber into a silk-like substance. Mercerized cotton, however, will never replace silk, although there is, without doubt, a large field for its use.—New York Sun.

THE PHARMACIST'S INK.

A GOOD ink is more of a necessity to the druggist than to any other tradesman. His writings are all "records," and he stakes much upon them. Moreover, his written directions are subjected to all sorts of ill-treatment and abuse, by both animate beings and inanimate things, unavoidably so far as he is concerned, yet he must be responsible. The annoyance which he feels when a prescription bottle is returned to him to be refilled, with the label streaked with internal remedies externally applied, the ink partially washed away or run together, and the writing bleached out, covered with slum gudgeon or otherwise obliterated, is always tinged with anxiety lest he fail to reach exactly the right conclusion regarding its first condition. It is far easier to decipher illegible prescriptions than to puzzle out smooched or bleached labels. It is also safer.

To secure an ink which exactly meets the conditions is not easy. The demands are rigorous. The ink must of course flow well and give a good initial color. It must dry quickly and not run when afterward it is wet. It must not fade easily, and must resist the action of chemicals to at least a moderate degree. It should keep well under ordinary conditions, and should neither corrode nor foul the pen immoderately.

Any one of these conditions can be secured easily, but the combination is not easy. Yet given a good formula, the preparing of an ink by the pharmacist is no more difficult than the preparing of a tincture or an elixir, and the saving in cost is as proportionate. Furthermore, it is much easier to make one's ink than to analyze or test a commercial ink.

The conditions are best met in an ink consisting of iron sulphate combined with tannic and gallic acids in proper proportions. An excess of either acid or iron will be detrimental. Such a combination does not give a good initial color, but writes pale, and the writing turns a jet black after a few hours' exposure to the air.

A carbon ink would not trouble in this regard and would be more resistant to chemicals, but it is much more likely to smooch and to wash away. The iron sinks into the paper and combines with its fibers better. The proportion of gallic and tannic acids to iron has been well worked out by chemists, and the only difficulty lies in securing a good initial color. Coal-tar dyes will either not dissolve in an iron ink, or if dissolved will precipitate the iron salt. Indigo paste, or indigo carmine, is the color most generally used. This is liable to be very acid as it is obtained in the market, and if used too freely will corrode the pens rapidly and even destroy the paper. A little acid is beneficial to the ink, keeping it in better condition, and an occasional corroded pen is of less consequence than the quality of the ink. Indigotin, a dye substitute for indigo, can be used in place of indigo carmine with satisfactory and more constant results.

Mr. J. A. S. Woodnow, under the writer's direction, has tried some twenty-five different ink formulas, including the Massachusetts standard formula. The inks were prepared from pharmaceutical chemicals and tested at the prescription counter during a period covering nearly two years. The formula which gave the best satisfaction is as follows: Tannic acid, 80 grains; gallic acid, 14 grains; salicylic acid, 1 grain; ferrous sulphate (granulated), 102 grains; indigotin, 90 grains; water, 1 pint. Dissolve the acids in 8 ounces of water, the iron and indigotin each in 4 ounces of water, and mix the solutions.

This writes a greenish-black at first, changing to jet black on standing. It dries readily, does not rub or run, and is almost fadeless. During the time in which it was kept, it appeared to be permanent and satisfactory.

The addition of a little sugar (one to two ounces) will make it of service as a copying ink. An equal amount of acacia will add to its permanence and render it more glossy, but it will not flow quite as well and will foul the pens. It should be remarked that a good quality of water should be used in making an ink, since the iron is easily oxidized by dissolved air or precipitated by other matter. The writer would be pleased to receive reports from pharmacists who may choose to try the formula given.—Portions of an article read before the Massachusetts Pharmaceutical Association by Professor Wilbur L. Scoville, and reprinted in The Spatula.

THE ELECTRO-CHEMICAL AND ELECTRO-METALLURGICAL INDUSTRIES IN 1899.

By JOHN B. C. KERSHAW, F.I.C.

THE year 1899 has been marked by steady advancement in several of the industries with which this annual review of progress deals; and in one industry the growth has again been phenomenal.

The aluminium industry, the industries based upon the electrolytic decomposition of salt and the copper refining industry, all exhibit signs of healthy expansion; while in the calcium carbide industry the rate of growth has been extraordinary, and in the writer's opinion, has been too rapid to be sound.

No new electro-chemical or electro-metallurgical process of any industrial importance has been introduced to the public during 1899; but two processes since the preceding have been developed, and works for their operation on a large scale are now in course of erection. One electro-chemical works has closed during 1899, and one other has, for the second time, met with difficulties which have necessitated the temporary cessation of manufacturing operations. As a set-off to these failures, a large number of new factories for the operation of processes already at work on an industrial scale have been planned, and some of these have already commenced production.

The only litigation during 1899 has been that carried on between the Castner-Kellner Company and the Commercial Development Corporation with reference to the validity of the patents for the Rhodin cell. The judgment of 1898 has been reversed, on appeal, in favor of the latter company, but it is expected that the case will now be carried before the House of Lords.

The details for the separate industries are given below:

ALKALIES AND BLEACH.

No new electrolytic alkali processes have come under the writer's notice in 1899, beyond those which form the subject of patent applications only. As space is limited and inventors are prolific, no attempt is made to deal with these in this review. The Greenwood process, to which reference was made a year ago, has not fulfilled expectations, and the trials at Winsford have been stopped.

The Rhodin process has made its reappearance in America, and the American Alkali Company, with a capital of £120,000, has been formed to work this process at Sault Ste. Marie. Electrical energy at this spot is estimated to cost only 42s. per E.H.P. year. The Commercial Development Corporation receives £108,000 for the American patent rights of the Rhodin process and cell. For a patent which has not received, as far as the writer is aware, industrial trial, and may

still have to face extended litigation, this price is undoubtedly satisfactory from the vendor's point of view. Whether the purchasers have reason to be equally satisfied with the bargain, is a question to which a decisive answer may be given two years hence.

The Hargreaves-Bird process has during 1899 entered upon the third and final stage of its development, a company with a capital of £500,000 having been floated for purchase of the English patents, and erection of a works at Middlewich, in Cheshire. The new company—the Electrolytic Alkali Company—is to pay £100,000 to the Parent Company for the patent rights in the United Kingdom. The projected works at Middlewich will require about 3,500 H. P. (steam or gas power will be used) and are estimated to cost £140,000. This process is now being operated industrially in France; the St. Gobain Chemical Company, after lengthy trials, having bought the French patent rights.

The Castner-Kellner process is developing rapidly, and there are now three works which use this process in operation—at Weston Point, Niagara, and Osternienberg—while two are building, the one at Jenappe, in Belgium, and the other near Moscow. The works at Weston Point have been completed during 1899, and 4,000 H. P. is now available for the production of alkalies and chlorine at this place. The total expenditure upon plant and machinery has been £292,000 and the capital of the company is being increased to £450,000. The operation of this works for the year 1898-99 was financially successful, and an 8 per cent. dividend has been declared. The Mathieson works at Niagara are also a success, and extensions are now in progress.

The Richardson & Holland process at St. Helens, as noted above, has met with further difficulties during 1899, and the works have been stopped for alterations and repairs during a portion of the year.*

The processes worked by the "Elektron" Company at Griesheim, and by the Bitterfeld Company at Bitterfeld (both diaphragm processes), are extending even more rapidly than the Castner-Kellner process, as the following list of places, where works, using one or other of these processes, are in operation, will show:—Griesheim, Bitterfeld (2), Rheinfelden, Ludwigshafen, Westeregeln, Montiers, La Motte, Zombkowice, Slaviansk, and Flix, in Spain.

This progress has been independent of the amalgamation, to which reference was made in the last report, of the two Parent Companies. During 1899 further changes in the financial organization have been made, and the Allgemeine Elektricitäts Gesellschaft, of Berlin, is putting an additional £180,000 into the Parent Companies.

The Hulin process, at Clavause, in France, is reported to be working satisfactorily, but manufacture by this process has not yet been commenced in other countries.

The Kellner process at Hallein, in Austria, is still operated on a comparatively limited scale; arrangements have, however, been made during the past year for the provision of the capital required to complete the works as originally designed. The Le Sueur process, which has been operated since 1893 at Rumford Falls, U. S. A., has succumbed during 1899 to the fall in prices of heavy chemicals in New York, and the plant at this works has been stopped.

In addition to the processes named above, others of which no details are available are already being utilized, or are about to be utilized, at the following places: St. Michel, Chevres, Monthey, Thusis, Cumberland Mills, Michigan, and at two unnamed places in Italy and North America.

The electrolytic alkali and bleach works in operation in Europe and America will, therefore, shortly number 29. When one recalls the fact that ten years ago there was not a single electrolytic alkali works in existence, the progress is seen to have been remarkable.

ALUMINIUM.

Although the number of works producing aluminium is now only six, the output of the metal is increasing; this increase being due to the concentration of the manufacture at the larger works.

The projected aluminium works at Sarpsfos, in Norway, is still unbuilt, the capitalists responsible for the developments at this place having decided that calcium carbide is the more profitable product.

Owing to the refusal of the European Aluminium Companies to supply figures of their output for publication, the writer is unable to give any detailed production figures; but the totals for the three years 1896-97-98 are believed to have been as follows: 1896, 1,789 tons; 1897, 3,394 tons; 1898, 3,958 tons.

The price of aluminium has remained fairly stationary during 1899, and it is hardly probable that any material reduction in price can occur with the present methods of extraction. The price at which aluminium is being sold for conducting purposes, 14½ d. to 15 d. per pound, will leave little or no profit to the producers.

There have been considerable additions to the capital accounts of the leading aluminium companies during the past year—the Pittsburg Company, the Foyers Company, the Neuhausen Company, and the Le Praz Company having all raised fresh capital for extensions during 1899.

As three of these companies have taken up the manufacture of calcium carbide, it is impossible to say what effect these increases will have on the aluminium industry.

No new process for the production of the metal has received industrial trial during the past year. The Peniakoff process, to which reference was made in the last review, has apparently failed to answer the expectations of those interested in it, for direct inquiry has failed to elicit any information concerning its progress. The only two processes for aluminium production in actual operation are, therefore, still the Hall and Herault processes.

The chief feature of 1899 with regard to the utilization of aluminium has been the extension of its use for conducting purposes. Owing to the high price of copper during the past year, electrical engineers have been disposed to try the new metal, and in America especially a large number of aluminium transmission lines have been installed.

The behavior of these eight aluminium power transmission lines, carrying, in the aggregate, 9,000-12,000 H. P., at pressures ranging from 10,000-20,000 volts, will be studied with interest by all electricians. The use of aluminium for telephone and electric light work is also being experimented with in this country, but the proverbial caution of our race hinders rapid progress in this direction.

With regard to other uses of aluminium, the most striking progress during the past year has been in connection with the application of aluminium to printing work.

As a substitute for stone it is rapidly gaining favor, and in both Germany and America "aluminography" is becoming a special branch of the printing industry.

There is little progress to report in other directions during 1899. The contributions of Ditte to the French Academie des Sciences have somewhat shaken the confidence in the durability of aluminium when exposed to atmospheric or other influences; and despite Moissan's defense of the new metal, it is felt that further practical trials are necessary.—English Electrical Review.

* Since writing the above the writer has learned that great improvements have been effected in this process during 1899; and the electrolytic plant at St. Helens is again in operation.

ANIMAL ELECTRICITY.

By W. S. HEDLEY, M.D.

GALVANI'S experiment was this: Laying the nerve muscle preparation on a glass plate, the nerve was raised with a glass rod, and then being allowed to touch the muscle, a contraction ensued. This was the demonstration of animal electricity, the existence of which Volta had denied. But Volta proved his assertion (which Galvani had denied) that metals in contact with a fluid produce an electric current. The demonstration of this latter fact was the discovery of the Voltaic cell.*

Animal and metal currents were first clearly differentiated by Du Bois-Reymond. He considered, and it is difficult to prove the contrary, that a natural electric current exists in normal resting muscle, "current of rest." During the action of the muscle he proved the existence of a current in the opposite direction to the "rest current." This was called "the negative variation," now known as the "current of action." Hermann combats the opinion that a resting uninjured muscle shows any current, and holds that the so-called "current of rest" is the result of chemical or other inequalities due to the injury. The views of English physiologists are as follows:

1. Normal muscle or nerve gives no current.
2. Local injury produces a current through the muscle from the injured to the living part.
3. Local action produces a current through the muscle from the active to the resting part.

Thus an injured or an active muscle produces electromotive force, and as in the Daniell cell the current goes from the active plate (the zinc) to the copper, so does current travel in the injured muscle from the injured part to the sound part. When the circuit is completed through a galvanometer, of course the direction is reversed, and it is usual to describe the direction of a current in its relation to the galvanometer. The manifestation of the sudden difference of potential which is the result of stimulation is sometimes spoken of as the "excitatory variation" when the muscle is referred to, and as the "action current" when the galvanometer is referred to.

The Negative Variation.—If a muscle giving the muscle current ("injury current") be tetanized, an action current will proceed from the uninjured to the injured part, i. e., from the part more capable of action to the part less capable of action. This current being in a direction opposite to the muscle current (injury current) constitutes a counter electromotive force which tends to cut down or diminish the muscle current, and this diminution is the "negative variation" of Du Bois-Reymond—"action current of Hermann."

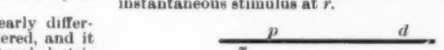
The Diphasic Variation.—A contraction wave propagated along the fiber of an uninjured muscle is accompanied by an electrical disturbance traveling from the active to the resting part, and this variation (as revealed by a galvanometer uniting two electrodes placed at an interval on the surface of a muscle) is double or diphasic for the obvious reason that the action is not simultaneous throughout the muscle, but requires time for its transmission.

By far the most striking manifestations of animal electricity are, of course, to be found in electric fishes; here the nerve surfaces represent the active element of the battery, viz., the zinc in the Daniell cell.

The electromotive action accompanying voluntary muscular contraction in the human subject has been demonstrated by Du Bois-Reymond, and that accompanying tetanic contraction from electrical stimulation by Hermann. Physiologists consider that the variation of electrical potential from the beat of the human heart has been demonstrated. It is by some regarded as proved that the white columns of the spinal cord give electrical signs of nerve action, and even that action currents are manifested by the gray matter of nerve centers. The skin of all animals is traversed by an electrical current from without inward. This is considered to be caused chiefly by cutaneous glands, but partly by the skin itself, as is proved in the case of the eel, whose skin has no glands. The action of light upon the retina causes an electrical change, i. e., a current accompanies retinal activity, as it does muscle activity. Indeed, it is probable that electrical phenomena always accompany vital action.

Certain of the above points have been carefully studied by Sir J. Burdon-Sanderson, and his latest contribution to the subject comes in the form of the Croonian Lecture delivered before the Royal Society, for an abstract of which we are indebted to the pages of Nature. As might be expected from the direction of his previous investigations, it was the electrical rather than the chemical or mechanical concomitants of the function of muscular action that chiefly engaged his attention. But it was necessary to begin by explaining some points in connection with the mechanical effects. These could be investigated in two ways: (1) By observing and recording the changes of form a muscle undergoes when, in response to a stimulus of short duration, it acts isotonically, as in lifting a weight; or (2) by observing the increase of tension which occurs in overcoming a resistance, i. e., when it acts isometrically. The latter method is the best when dealing with an entire muscle, but isotonic conditions are preferable when estimating the time occupied by a single element of muscular structure in developing its maximum tension under stimulation.

The method employed consists in observing the change of surface form that occurs in a muscle when a single break induction current is led through it in such a way that the observed surface is at the cathode. A sensitized plate moves behind a slit, upon which a magnified image of the cathode (moving freely with the muscle) is thrown. An observation thus made shows that the process of contraction at the point immediately excited, i. e., at the point immediately underneath the cathode, attains its greatest activity before the end of the first hundredth of a second. It is known, as already stated, that an electrical change, an action-current, accompanies the mechanical change, i. e., the change of form which a contracting muscle undergoes. Are the change of form and the electrical variation synchronous, or does one precede the other? On connecting two parts of the surface of a muscle through a capillary electrometer or other galvanoscope, it is found (1) that similar parts in a similar physiological state are equi-potential; (2) that in similar parts, but in a different state, there is a difference of potential the less capable of function, i. e., the less living being negative to the more living; (3) that transitory differences of potential arise between two parts of the living surface when the one is active and the other resting, the condition of rest or fitness for function being denoted by relative "positivity," discharge of function by relative "negativity." The "first fundamental experiment" was then described. A parallel-fibered muscle (curarized) is submitted to an instantaneous stimulus at *r*.



The result is that a wave of excitation passes along each fiber, its progress being marked by electrical and mechanical change. The latter consists of an alteration of shape or contour in the contracting muscle. If we have two contacts, *p* and *d*, applied to different parts of the contracting muscle and connected through a galvanometer, the electrical effect of the stimulation appears; it consists in the sudden manifestation of a difference of potential between the two parts of the contracting muscle.

Now, reverting to the mechanical effects (alteration of contour) produced by the stimulation, the photographed curve represents the wave of excitation as it starts from the point of stimulation, *r*, affecting first the near contact, *p*, and then the distant one, *d*. But if, by tying a tight ligature across the path of propagation, we limit the observation to what happens at one contact only, "we find that the curve has assumed an entirely different form." It is natural to conjecture, and capable of proof, that the difference of contour in the two experiments represents the arrival of the wave of excitation at the distal electrode, *d*. A curve representing the change which occurs in the difference of potential between the surface of contact, *p*, and the rest of the surface of the muscle during excitation can be obtained by calculation from measurements of the polar ordinates of the curve resulting from the first experiment. Assuming an identical curve at *d*, but relating to a period 15,000ths of a second later, we may obtain the curve which expresses "what must be the successive differences of potential between *p* and *d*, when the effect of the change at *d* is not canceled." If the curve be deduced from the second experiment, i.e., where the change at *d* is canceled, it coincides with that obtained by summation, where the change at *d* is not canceled. Therefore, from *p*, we can obtain the curve which expresses the successive differences of potential required, and the determination of the monophasic variation ought to be the aim of such experiments.

The curves that represent the change of contour also represent the electrical response to excitation. The electrical state of the muscle when at rest depends upon the way in which the effect of the wave of excitation at the distal electrode is canceled. If this be done by applying a ligature between *p* and *d*, the contacts remain equi-potential; if the part of the nerve to which *d* is applied be de-vitalized, e.g., by heat, the unexcitable dead surface is found to be strongly "negative" to the other.

It thus becomes evident that the phenomena observed depend "exclusively upon the state of the surfaces of contact, and consequently, when the distal contact is canceled, on that of the proximal contact only."

Having considered the electrical results of a single instantaneous excitation, further experiments were detailed, showing the electrical concomitants of continuous contraction. It has been contended that the continuity of voluntary muscular action is apparent only, and an identity in sound emitted by muscle contracting normally, and one contracting under a series of instantaneous stimuli, has been adduced in favor of this view. "It is argued because we can produce continuous contraction (artificial tetanus) by discontinuous stimuli, that all continuous contraction is so produced." Putting such questions aside, and limiting attention to the electrical concomitants of continuous action, it was shown that under certain conditions a continuous contraction can be produced by a single uninterrupted stimulus, and that in reflex spasms there is no evidence of discontinuity, "at least, in the sense in which this term is ordinarily understood." There is rhythm, but it is central, not muscular. If spasm be artificially produced by exciting the motor apparatus through a sensory nerve, the cells of the cord having been rendered hyper-excitable by a dose of strychnia, a prolonged contraction occurs, the graphic tracing of which is often distinguishable from that of complete tetanus. But by analyzing the electrical concomitants as recorded photographically, it is seen that the curve resembles rather that of complete tetanus interrupted at regular intervals than that of a series of responses to single instantaneous stimuli following each other at $\frac{1}{10}$ of a second or more. Thus a single stimulus to the motor cells of the cord has produced a series of responses in the muscle, but, as already stated, the rhythm is central, i.e., the motor

* For this and a portion of the following, see "Therapeutic Electricity," by W. S. Hedley, M.D. (Churchill, London.)

cell has discharged its influence on the muscle at regular intervals, but the effect each time is that of continuous action.

A further interesting point in this connection was adverted to, and lies in the fact that by means of the alkaloid veratrine we can abrogate the mechanism by virtue of which a muscle, after responding to an instantaneous stimulus, returns to its previous state. In other words, under the influence of veratrine a muscle once thrown into action is compelled to continue that action, and the electrical phenomena under such circumstances show the effect to be absolutely continuous. The curve resembles that of artificial tetanus, showing no undulation or unevenness. Although the excitation is instantaneous, the response is continuous, and it is remarkable that a muscle so treated preserves its functional capacity unimpaired. In other words, a veratrinized muscle excited by an instantaneous stimulus will lift as great a weight, or do as much other work, as a normal muscle excited by a succession of instantaneous stimuli.

The contractions of the heart are analogous to those of the skeletal muscles, but, of course, the "relative negativity" spreads radially instead of longitudinally, the electrical effect appearing to precede the mechanical; but the duration of the process is longer, and the rate of propagation slower.

It was then explained that if the leaf of the Venus' flytrap be explored in a similar way, changes occur analogous to those observed in the ventricle of the frog. But the interval of time between the culminations of the electrical response and that of the change of form is more obvious in the leaf than in the heart, for the reason, as the lecturer concluded by observing, that the mechanism by which the change of form shows itself works more slowly in the leaf than in the heart.

It does not seem quite clear how far the above experiments having reference to the time relationship between the electrical and the mechanical concomitants of contracting muscle bear upon certain other views on the same subject which certainly seem plausible. It is known that derangements in shape, produced mechanically, will show themselves electrically, i.e., will produce the electric state, and conversely, that variations in the electric state are accompanied by derangements in shape. According to D'Arsonval, given a surface that can be disturbed mechanically, as, for example, in all liquid and semi-liquid bodies, similar phenomena occur. Therefore it is sought to explain action currents by variations in surface tension, and consequently in the electric state, which is due to the "internal mechanical distortion that occurs in every living tissue which is undergoing change of shape." There is little doubt that the mechanical event, the change of form in a muscle, actually commences before it becomes apparent. It has been considered demonstrable that the electrical event actually accompanies the mechanical event. Could it be shown that the electrical disturbance is an event, actually as well as apparently, anterior in point of time to the actual change in shape, such an observation is clearly fatal to the last-named theory.—English Electrical Review.

VERTICAL CROSS TURRET LATHE.

It is very pleasant to us to be able to put before our readers, says London Engineer, a purely English machine tool which we have no hesitation in saying is, in no single point, behind the best American practice, and is in some ways superior to any other tool of foreign or British make doing the same class of work. The machine, of which a back and front view are given, is made by the Wolseley Sheepshearing Machine Company (Limited), Birmingham, and is, we believe we are correct in saying, almost entirely the invention of Mr. H. Austin, a gentleman who has contributed many instructive letters on machine tools to our correspondence columns.

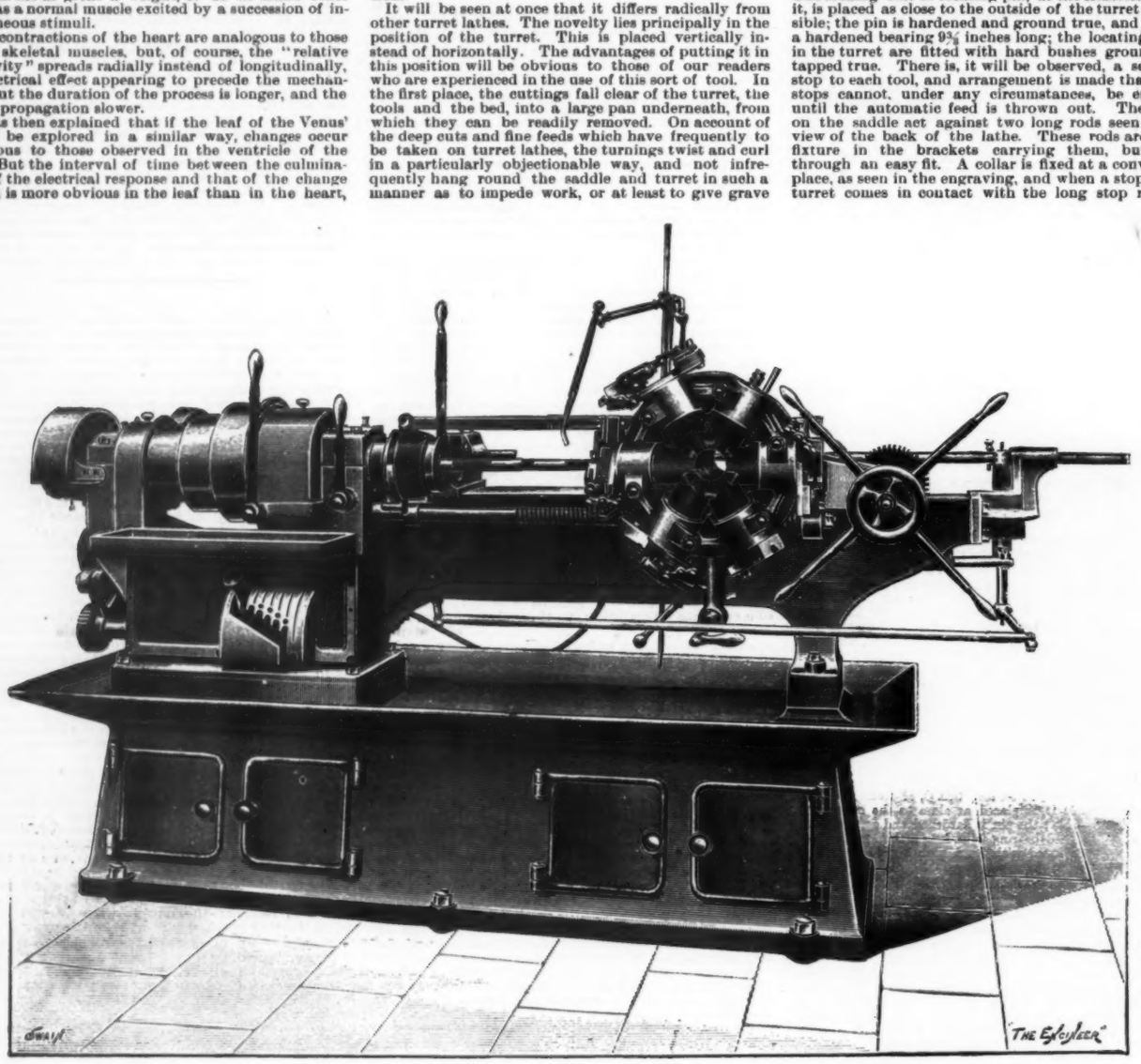
Before describing this machine in detail, we wish to call attention to the main features of its design, and to discuss the reasons which have led to their adoption.

It will be seen at once that it differs radically from other turret lathes. The novelty lies principally in the position of the turret. This is placed vertically instead of horizontally. The advantages of putting it in this position will be obvious to those of our readers who are experienced in the use of this sort of tool. In the first place, the cuttings fall clear of the turret, the tools and the bed, into a large pan underneath, from which they can be readily removed. On account of the deep cuts and fine feeds which have frequently to be taken on turret lathes, the turnings twist and curl in a particularly objectionable way, and not infrequently hang round the saddle and turret in such a manner as to impede work, or at least to give grave inconvenience. But apart from this altogether, the wear and tear on the sliding faces is reduced by putting the saddle in such a position that the finer pieces which fall away in front of the cutting edges of the tools cannot get beneath the saddle, where they would increase the difficulty of moving the saddle and scratch the faces. Then, again, the position of the tools is such that the operator can see how the work is progressing without having to stoop over the machine, while the stops are so arranged that the distance the tool has to travel can be seen at any point. Another useful feature is that the turret can be revolved either way immediately each tool has cleared the article being turned, no matter what variation there may be in the length of the tools. The turret is revolved automatically in either direction at will, without any previous setting of stops, and then fixed only at the positions necessary for the work in hand. There are two other points to which attention may be called here, although they will be more fully appreciated when the details are described. One is the closeness of the center line of the spindle to the top of the bed, and the closeness of the lead screw to the center line of the spindle.

We now pass on to a detailed description of the principal parts.

The chuck body is forged solid with the spindle and hardened and ground true all over, and it is, therefore, reasonable to expect that it will keep true for a considerable time. It will take rough shafts up to 2½ inches diameter. The spindle is hardened, ground, and lapped, has ball thrust as shown, and runs in hard phosphor bronze bearings, the front 5¾ inches long by 3⅜ inches diameter, and the other 4½ inches by 3⅜ inches.

There are one or two points particularly to be observed about this whole arrangement. In the first place, the great length of the saddle should be noticed, and the breadth of the bearing surfaces; the method of holding the adjusting gib, as seen in the cross section, will be appreciated by those who know how many indifferent ways there are of fitting such keys. Then attention must be called to the position of the stops. In several automatic machines the stops are placed in such positions relatively to the tool head that adjustment is not an easy matter, and that the effect of any play or backlash is considerably magnified. Here it will be observed that the stops are so placed that they can be got at with the greatest ease, and that they are in direct line with the cutting tools. The locking bolt or locating pin, as the Americans call it, is placed as close to the outside of the turret as possible; the pin is hardened and ground true, and fits in a hardened bearing 9¾ inches long; the locating holes in the turret are fitted with hard bushes ground and tapped true. There is, it will be observed, a separate stop to each tool, and arrangement is made that these stops cannot, under any circumstances, be engaged until the automatic feed is thrown out. The stops on the saddle act against two long rods seen in the view of the back of the lathe. These rods are not a fixture in the brackets carrying them, but slide through an easy fit. A collar is fixed at a convenient place, as seen in the engraving, and when a stop in the turret comes in contact with the long stop rods, it presses the collar against a lever which throws out the feed, and then, by moving forward the turret by hand, the lever is jammed in between the collar and the casting carrying the long rod, and this acts as a fixed stop. The shank or spindle of the turret is 4½ inches diameter by 11¼ inches long. The tools used for plain turning are made from steel bar without forging, hardened the whole length, and ground at the end. Each end may be used, and by swiveling the locking bolt any desired degree of side rake may be given, or the tool set over to cut in the opposite direction.



VERTICAL CROSS TURRET LATHE—FRONT OF MACHINE.

Each tool-holder is also provided with a special form of rocking support or steady. It is in only one piece, and may be firmly locked in position. Owing to the position and shape of the holders, the work may be readily calipered close to the tool without stopping the lathe or waiting until the tooled surface projects through the holder.

The lead screw is used only for screw cutting, and although it is quicker to use a die for some jobs which are not required to be accurate, it is very handy to be able to cut a true thread right up to a shoulder, or to cut very coarse or square threads which it would be impracticable to cut with a die. It is also often necessary to cut a few threads which are not standard pitches or sizes, and would not pay for a special set of dies to be made.

The reversing motion to turret slide is so arranged that in cutting threads which are not multiples of the pitch of the lead screw, the tool always drops in at the

right place. This is very convenient in cutting short quick pitch threads, as the cutting may be done on the slow speed and the quick speed used for running back. The reversing mechanism and most of the screw-cutting and feed gears are made out of mild steel, and those subject to extra wear are case-hardened.

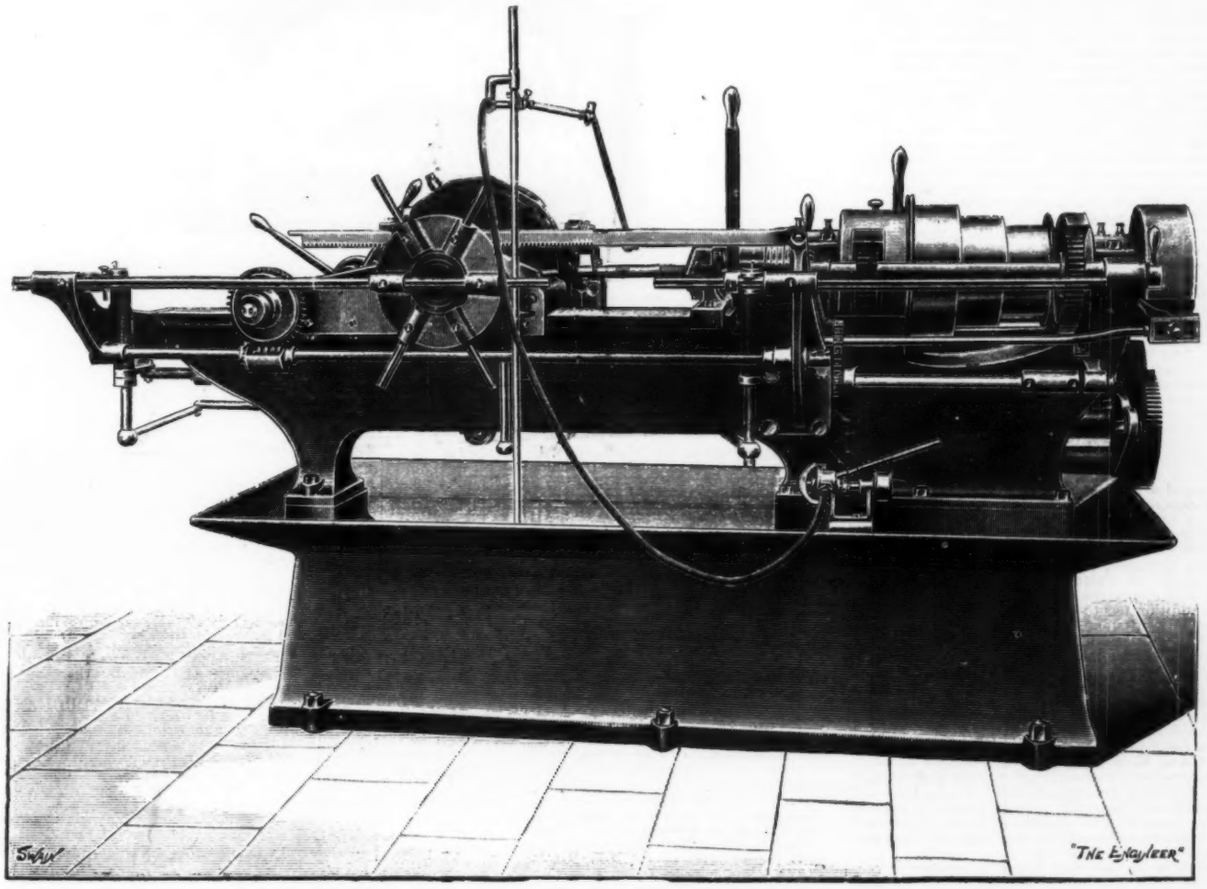
The alignment of the spindle with the bed is tested by chucking a piece of 2½-inch steel shaft and turning two narrow collars at one setting of a tool in the turret, one collar being near the chuck and the other nearly 2 feet away. As the shaft is stiff enough to take a light cut, no steady rest is used, and, consequently, any error is doubled. The spindle gears and wheels used for screw cutting and feeds are well protected, and are readily got at for repairs or inspection.

Mr. Austin informs us that he contemplates the construction of other sizes of this machine, and that a tool on similar lines for dealing with castings instead of bar is being designed.

THE PROGRESS OF AUTOMOBILISM IN 1899.

ALTHOUGH nearly everyone admits that motor cars have become more common on our roads, it is only those intimately connected with the motor car industry and those who take an interest in the question of automobilism who can fully realize the immense progress that has been made during 1899. Now that we have just entered on a new year, it may not be amiss if we briefly review the course of events in the automobile world during the past twelve months, and to begin with, we think we are safe in stating that not in any year since the act which freed "light locomotives" from the restrictions which previously prevented their progress through the street unattended by the "red flag" and its bearer came into operation have the advances made been so great, relatively, as during 1899. The causes for this rapid expansion are not far to seek. Frequent trials of both a public and private character have demonstrated to positive conviction (1) that road locomotion by automobile vehicles is possible; (2) that it is unaccompanied by any other danger than is progression by horse-drawn vehicles; (3) that in the hands of competent persons the mechanism of a properly constructed motor vehicle is not liable to internal breakdowns or ruptures; (4) that the expense of up-keep, as well as the cost of traveling, is less with an automobile vehicle than with horse-drawn carriages; (5) that the potential traveling capacity of an automobile vehicle for any given period is considerably greater than that of the various trials of automobile vehicles that have taken place in this country during the year, including those of the Liverpool Self-Propelled Traffic Association in January and July, of the Motor Car Club in May, of the Automobile Club in June, the Commercial Efficiency Trials of Motor Car Journal in July, and the 100-mile trials of the Automobile Club in the autumn; besides, the innumerable tours and trips organized by these clubs and associations have all served to convince even the most skeptical that automobile locomotion has passed through its first stages of experiment and is now emerging, if it has not already emerged, into a strictly practical stage of definite manufacture. Improvements in detail are, of course, continually being made, just as they are in locomotives at the present day, even after some sixty years of successful working. We do not desire to convey that perfection has been reached, but we do wish to place on record the huge advancement which twelve months have brought about.

Dealing first with vehicles propelled by means of petroleum-spirit motors, which still lead the way in point of numbers, many new vehicles, some of original design, have seen the light. The two largest concerns have been busily engaged in the production of vehicles of the Panhard type, in which such improvements and modifications have been made as to earn for them an unexcelled reputation. The feature of the year in this branch has, however, been the increased attention devoted to the production of a lighter type of petrol-car than the Daimler. Space is not available to mention the whole of the new cars which have been introduced, but examples of the type referred to are to be found in the Critchley, "Princess," Marshall, Humber, Beeston, Lanchester, Endurance, Ivel, and Blake cars. The Benz car maintains its popularity, an indication of which is to be found in the fact that cars on similar lines are now being constructed in this country by several concerns, notable among which is the Star Motor Company, of Wolverhampton. British firms are beginning to devote increased attention to light two-seated voiturettes. Of this type the Accles-Turrell, the Osmond, Humber, Progress, and the Jackson Doctor's cars may be mentioned.



VERTICAL CROSS TURRET LATHE—BACK OF MACHINE.

In regard to engines taking power from explosive admixtures of the vapors of paraffin oils in conjunction with air, there has been little progress. Messrs. Roots and Venables still continue to successfully utilize engines worked by heavy oils, while the McLachlan Engine Company and Messrs. Geering have entered the lists in this branch, in which, however, it cannot be said that much development has taken place. The difficulty which appears to be insurmountable is in regard to the fumes of the gases exhausted from the cylinders. It is apparently impossible to thoroughly deodorize these fumes with certainty and under all conditions of running, starting, and stopping, and thus the system of using heavy oils has made but a slow advance.

Coming now to steam vehicles, the advance in this department has been great. In 1896 we ventured to prophesy that England, which had for so many years held a pre-eminent position in the utilization of steam power, would soon be found in front of her Continental rivals, in spite of the long start which the latter had in carrying out experiments. The prophecy then made has been fulfilled to the letter, and to-day we have pleasure in putting on record that England is at the front in this section of self-propelled locomotion. During the past year our constructors have supplied steam road vehicles for use on the Continent, in South Africa, in Ceylon, and in a great many provincial centers of Great Britain, as well as in the metropolis. The reason for this is at once apparent on an examination of the steam vehicles of Continental and British constructors. Those of Continental origin are in the first place much too heavy, besides too wide and too large to render their use possible under the stringent conditions laid down in the Light Locomotives Act and the Local Government Boards' regulations. In the next place, the complications of their mechanical details are much too severe to pass muster in England. Those constructors in England interested in steam vehicles for heavy loads complain, and we think with justice, of the stringency of the British regulations; but there is no doubt in our mind that it is this very stringency that has acted as a spur in necessitating the overcoming of those difficulties to which these regulations give rise. The narrowness of width laid down in the regulations and the weight restrictions have caused British ingenuity to be exercised most profitably, with the result that to-day the engineers of England are producing steam vehicles for heavy loads which owe no part of their design, equipment, or method of construction to foreign inventors, and which are, moreover, capable of competing successfully and commercially against the steam vehicles produced in any other country.

While suggesting that in some measure the success of English built heavy steam vehicles is due to the onerous conditions imposed, we do not wish it to be for a moment imagined that we are against the proposal to increase the tare-weight limit. On the other hand, we think the time has now come when the Local Government Board should have no hesitation in meeting the demands of builders of this type of vehicles, which at Liverpool in July and August last were submitted to almost every conceivable test. During the year considerable improvements have been effected in the heavy steam wagons already on the market twelve months ago, notably in the Thornycroft wagon, which took the gold medal in the trials at Liverpool. New steam wagons have also been brought out by Messrs. Simpson & Bodman, Messrs. Bayleys, Limited, Messrs. Toward & Company, the Clarkson & Capel Steam Car Syndicate, the Verity Motor Company, Messrs. Musker, and Messrs. Beach. In passenger cars, Mr. C. T. Crowden has introduced a steam wagonette, but so far there is no light steam car available, of English construction, of the type now being turned out by several firms in America, although we hear of several experimental vehicles being in course of construction in different parts of the country.

As regards electrically propelled cars, much progress has been made, although the accumulators still continue to be the bête noire. The Headlands Company and Messrs. McKenzie have brought out some neat types of cars; Mr. C. Oppermann, too, has introduced a new frame and method of gearing, and when we last had a chat with him had something new on the stocks in the way of accumulators. Several new cars, in which electricity supplies the motive power, have also been brought to the notice of the automobile world, among which are the Joel, the Clift, cars of the Electric Motive Power Company, Limited, and those of the Electrical Undertakings, Limited. The last-named concern is sparing neither money nor time in its efforts to produce the ideal electrical vehicle, and the success achieved has been well shown by the runs its cars have made from London to Brighton on one

charge of the batteries. As mentioned above, it is the accumulator question which has still to be solved, and although much has been done, much remains to be accomplished ere electrical cars can become as popular as the builders of such vehicles would like to see them.

The advance in automobile road locomotion in England has been due not only to the competitive trials and pleasure tours mentioned in a previous part of this article, but also to the public exhibition of vehicles in an organized manner. The exhibitions of motor vehicles held at Richmond in June and at the Agricultural Hall, Islington, in July last, too, contributed in no mean degree to the further education of those interested in the automobile movement in Great Britain. The latter was the largest and most complete show yet held in this country, and a large number of French and German vehicles and appliances not previously seen in England were exhibited for the first time. It was this exhibition, perhaps, which most forcibly brought home the fact to English constructors that there was a demand for a light two-seated motor vehicle, and that if they did not lay themselves out to market such a car their place would be taken by the Continental cheap, light, and gracefully designed vehicles. Several makers have taken the lesson to heart, and we know that some extremely graceful cars at a low price are now on the stocks and will be ready for the spring trade. The forthcoming exhibition in April next at the Agricultural Hall promises to be even more successful and instructive. Over seventy firms have already given their adhesion. The running or demonstrating track, 320 feet long and 100 feet wide, which was one of the features of last year's show, will again be one of the attractions.

Attention may now be briefly directed to the progress of the automobile on the Continent. Great as was the activity in the new industry in 1898, it has been even more pronounced than ever during 1899, particularly in France. Dividing our remarks on French progress into three sections—petroleum, steam, and electrical vehicles—and dealing with the first of these, we may mention that several new types of impulse motors have been designed and put on the market, and although some of these have yet to prove themselves efficient engines, many of them have already found a place for themselves. We may here mention en passant that quite a number of engineering firms in France, while not building motor cars themselves, are doing a large business in motors suitable for use on motor cars and cycles. The striking feature of the year in France has been the large amount of attention devoted to the production of light voiturettes to sell at prices ranging from £100 to £300, including those of De Dion, Peugeot, Mors, Bollée, Renault, Turgan-Foy, Underberg, and Phébus concerns. In four, six, eight, and more seated vehicles, the Panhard-Levassor, Peugeot, Mors, De Dietrich, Delahaye, and Hurtu firms still keep well in front. The number of makers of this class of vehicles has, too, been increased, the vehicles made by Gobron-Brillié, Henriod, and others each having individual features of merit and interest. Very little appears to have been done in France in the way of petroleum or heavy oil motor vehicles in contradistinction to petroleum-spirit, no new vehicle with a heavy oil motor having come under our notice during the past year, although the Compagnie des Automobiles, système Koch, are still building vehicles of this class. In another section, too, that of avant-train moteurs, or petroleum motors mounted complete, with the power-transmission mechanism on a fore carriage so that they may be fitted to existing carriages, comparatively little new work has been done. M. Pretot and M. A. Amiot are still at work on their respective systems in this class, to which only one addition has to be made—the Heilmann.

Coming now to steam carriages, nothing very new appears to have been done in France, the firms engaged in the production of this type of vehicle having devoted their attention to the perfection of the details of the old patterns. Messrs. Piat have introduced a heavy steam wagon, while a light car has been put on the market by the Société Européene.

As regards electrical vehicles, a good deal of work has been done in France during the past year. M. Jeantaud and M. Krieger have introduced considerable improvements in their electric cabs and broughams. The Mildé & Jenatzy electrical vehicles have also been considerably improved, while among new vehicles employing electricity as the motive power which have attracted attention during the year may be mentioned the Créanche and the Draulette.

Passing now to Germany, quite a number of new automobile clubs and companies came into existence during 1899, and these would appear to have given a considerable impetus to the motor car movement in that country. In addition to the Daimler Motoren Gesellschaft, of Cannstatt, Messrs. Benz & Company, of Mannheim, Bergmann's Industriewerke, of Gaggenau, Herr Moritz Hille, of Lobtau, Dresden, the Eisenach Fahrzeugfabrik, of Eisenach, and Messrs. Cudell & Company, of Aix-la-Chapelle, the construction of motor vehicles has been taken up, among others, by the Kuhlstein Wagenbau Anstalt, of Charlottenburg (petrol), Die Gesellschaft für Verkehrsunternehmungen, of Berlin (electrical), the Oggersheim Maschinenfabrik (electrical), the Bielefeld Maschinenfabrik (Durkoff) of Bielefeld (petrol), Messrs. Lange & Gutzeit, of Berlin (electrical), and Messrs. Hentschell & Company, of Berlin (electrical). In Belgium a fair amount of progress has been made. Three or four concerns—notably the Pieper Company, the Fabrique Nationale d'Armes, the Société de Construction Liégoise d'Automobiles, of Liége, Messrs. Vincke, of Malines, and Messrs. Dechamps—are already turning out motor carriages on a fairly large scale. Excellent advance is being made in Italy. In Switzerland a similar remark applies, there being now two concerns turning out motor cars on a commercial scale. In Austria very little actual manufacturing appears so far to have been done, the bulk of the vehicles in use—whose number is, however, steadily increasing—having been imported. One firm—Messrs. Jacob Lohner & Company, of Vienna—is, however, already turning out both petroleum and electric vehicles. In Holland and Denmark the same state of things prevails, while in Spain, although motor car vehicles have not yet met with a very large adoption, good work is being done in pioneering the horseless carriage movement in that country, and already several services of public vehicles are projected if not actually started. From Russia, Sweden, and Norway we have very little news as to what is being done, but if the large number of Swedish members of the Mid-European Motor Car Club is any criterion, it is evident that the matter is not being overlooked in that country.

Turning to America, if one were to judge from the number of new companies that have been formed, it would be expected that the motor car industry is already the most important in the United States! That this is far from being the case need not be said, yet beneath all the great company promotion business that has been going on during the past year there is evidence of a considerable amount of experimental work being in hand in every department—petroleum spirit, electrical and steam; and although there are probably at the present time only about a couple of firms in each of these classes turning out automobiles on a commercial scale, the present year is likely to see considerable developments across the Atlantic.

In concluding this review we would say that the year 1900 has opened with very bright prospects for those already established in the motor car industry; and while the number of firms comprised therein is likely to be increased during the course of the year just entered upon, we believe that the number of converts to the modern means of locomotion on common roads will progress at, if anything, more than a proportionate rate.—Industries and Iron.

A NEW DOUBLE SUPPLY COCK.

THE level at which the Opera Comique at Paris is situated differs sufficiently from that of the various reservoirs of the city to allow the theater to use both the water of the Seine and what is called spring water, the pressure of which is higher, as a general thing. In anticipation of cases in which one of these services might be arrested for the sake of repairs or some other reason, the two sets of pipes in the building have been so arranged that either can at will be supplied with the water that remains disposable; and this result has been obtained by means of a single cock placed at the junction of the service pipes.

This apparatus, therefore, had to satisfy the following requirements: Being given two distinct entrances of water: 1, to permit (without mixing the waters) of supplying the conduits, *S* (spring water) and *R* (river water) with either one or the other water, in case of the stoppage of the supply of either; and 2, to permit of shutting off the entrance of both waters.

To this effect MM. Muller and Rogers devised the cock represented in the accompanying figures, and the key of which is provided with six orifices, *m*, *m*, and a central partition.

In the position shown in Fig. 2, the two pipes are supplied by their respective waters. This is the normal situation. At *C* enters the spring water, which passes through *S*; and at *D* enters the river water, which passes through *R*. Fig. 3 shows all the pipes closed, and Fig. 4 gives the position in which the two pipes are supplied by the spring water. By turning the key sixty degrees, a supply of river water is obtained. Two stops, *t* and *t* (Fig. 1) limit the travel of the key to the positions shown in Fig. 4. The extreme positions of the key for the complete closing shown in Fig. 3 are situated respectively at sixty degrees from the axis and in the second half-circle not occupied by the stops *t* and *t*.

For the above particulars and the illustrations we are indebted to La Nature.

MONRO'S ENGINE COUNTER.

THE counter illustrated on this page is peculiar in that a toggle motion is used to operate the ratchet on the units wheel. The advantage gained is that less care is necessary in adjusting the stroke of the reciprocating arm operating the dial, as a considerable amount of over-running will not affect the indications of the instrument. The "follower" dials are driven each from a projection on the wheel preceding it. The dials, it will be seen, are arranged on the arc of a circle,

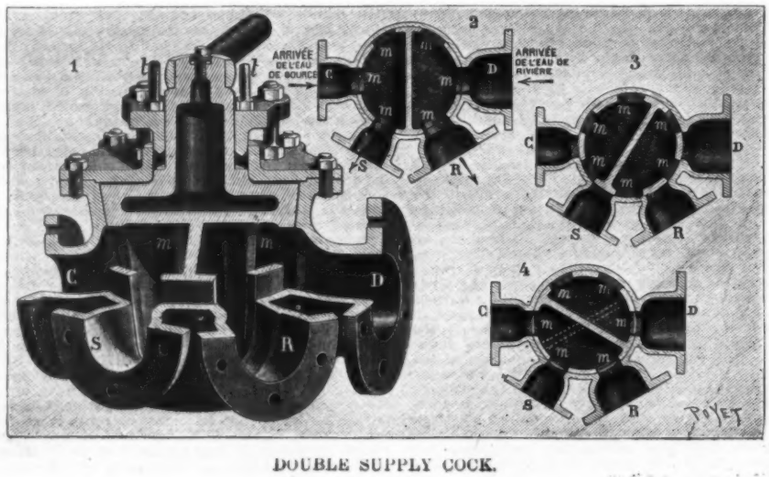
MONRO'S ENGINE COUNTER.

which permits of the projection referred to being placed on the side of a tooth in place of at the side of a space. The dials record up to 10,000,000 strokes, but can be easily set to zero when desired by opening the case, and then starting at the right-hand side, each dial showing a 9 or a 0 is moved on. This puts all the wheels out of gear with each other, and then, starting at the left-hand dial, each is successively put to 9, following which a single movement of the units wheel puts the whole to zero. Provision is made, as shown, for actuating the counter at will, by either a vertical or a horizontal reciprocation, the return stroke being made by the spring. The makers of the device are Messrs. Walker Brothers, of 168 Oxford Street, Glasgow.—Engineering.

A FRENCH PRIZE FOR AERONAUTS.

THE Paris Aero Club, which numbers among its members many of the young French nobility, has just offered a prize cup to be competed for by aeronauts. This has already stimulated adventurous balloonists to exertion, and may do a real service to science, since exploration and investigation of the upper air is now much needed in meteorology. M. W. De Fonvielle tells us in La Science Illustrée (December 16) something of the aerial cup contests just inaugurated. He says:

"The prize cup for aeronauts proposed in September, 1899, by a member of the Aero Club, to become in September, 1900, the property of the aeronaut who has made the longest trip between those two dates, start-



DOUBLE SUPPLY COCK.

ing from Paris, has been already competed for four times in six weeks, and has been carried off three times successively; first, by the Comte de la Vaulx and M. Mallet; second, by M. Farmann and M. Hermite; third, by the Comte de Castillon, M. St. Victor, and M. Mallet. The first were stopped by the ocean in the neighborhood of Rochefort, the second by the Mediterranean near Aix, and the third near Verterbuk, in Sweden. The distances traversed in these different records were increasingly large. The Comte de Vaulx was satisfied with 400 kilometers [248 miles], M. Farmann went nearly 600 kilometers [372 miles], and the Comte de Castillon nearly 1,300 kilometers [806 miles], crossing the North Sea and the sound on the way. This progress is remarkable. It shows that we are only at the beginning of surprises, even if the competitors do not exceed the limits of what it is possible to do without exposing life too seriously.

"The Aero Club celebrated the victory of the Comte de Castillon and M. Maurice Mallet by a banquet given under the auspices of the Comte de Dion. More than one hundred members were present, as well as some invited guests, among whom were M. Triboulet, general secretary of the French Society of Aerial Navigation. . . .

"Having learned that M. Janssen, the astronomer, had made choice of M. Mallet to take charge of his next scientific ascension, for the reason that he had made the best record for the cup, the Aero Club voted to place at the illustrious astronomer's disposal a fine new balloon which the society has just constructed.

"This ascension will be carried out in a short time. It will be only the third of its kind, but it will not be the last, for the approach of the Exposition will give an impulse to experiment, and the Aero Club has collected funds for a series of fifty trips, of which a great number will doubtless break the record and carry off the cup, which is destined to be celebrated. It will have a history of which we now know only the first chapters. May it never become tragic!"

The author gives us a few particulars of the record-breaking voyage of Castillon and Mallet, from which it appears that when their balloon, the "Centaur," descended in a Swedish forest on the night of October 1-2, 1899, the two aeronauts, after wandering about for some time, stumbled upon the hut of a woodman. The good man and his family were overjoyed, believing the balloon and its navigators to be the far-famed Andrée expedition! Probably that ill-fated airship was the only one that the Swedish peasants had ever heard of. We are told that the trip lasted nearly twenty-four hours and that the altitude varied by nearly two miles. Thus, the opportunities for scientific investigation offered by such a trip as this, where the observers actually occupy the balloon, are still superior to those presented by so-called "sounding-balloons," where the observer stays on the ground and sends up his balloon with self-registering apparatus, "taking soundings" of the upper air in something the same fashion as the marine investigator takes them, in the opposite direction, of the deep sea. The inventors of this method of aerial investigation, Messrs. Hermite and Besançon, still hold the record, but although they and their scientific brethren have brought out some interesting facts, the best method of exploring the upper air, M. de Fonvielle thinks, is to go there one's self; and so the Aero Club, with its record-breaking and its cup contests, may be regarded as really accomplishing something of value to science. —The Literary Digest.

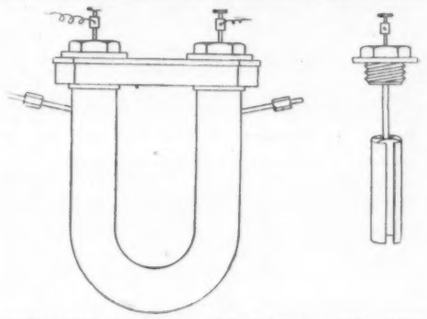
NEW APPARATUS FOR THE ELECTROLYTIC PREPARATION OF FLUORINE.

IN the train of our experiments made in conjunction with Mr. Dewar upon the liquefaction of fluorine, we resumed the study of the preparation of this simple body. Up to the present, we have obtained fluorine through the electrolysis of a solution of potassium fluoride in a platinum apparatus. At the beginning of our researches, we pointed out the fact that the platinum of the electrodes and of the apparatus itself is attacked, that a certain quantity of this metal enters into solution, and that from this moment the electrolysis becomes more regular. Now, the use of platinum and the wear of the electrodes and of the receptacle, which is quite rapid, renders this apparatus very costly. In order to ascertain whether or not it were possible to substitute another metal for platinum, we arranged wires at the bottom of the electrolyzing apparatus, and found that the preparation of the fluorine was effected just as it had been previously. We have remarked that, of the different metals employed in these experiments, copper is the one that is the least attacked, provided, however, that the acid is very free from water. This property, moreover, corresponds with those of the fluoride of this metal studied by M. Poulenc.

Starting from these preliminary experiments, we had a U-shaped tube constructed that possessed nearly the same form as that of our platinum electrolyzer. It was of larger volume (its capacity being about 300 cubic centimeters) and easily permitted of electrolyzing 200 cubic centimeters of hydrofluoric acid rendered conductive by 60 grammes of hydrofluate of potassium fluoride. The manner in which the apparatus was closed remained the same. The insulation was effected by fluorine stoppers, but the form of the electrodes was changed. In our previous experiments we used cylindrical platinum rods of which the extremity had the form of a club. Desiring to have a wider surface, we gave the electrodes the form of hollow cylinders open in the direction of one of their generatrices. We increased the surface in order to obtain a better rendering. These electrodes were always of platinum, since we were unable to employ copper for this part of the apparatus.

In some experiments made with electrodes of copper, this metal entered into solution at the beginning of the electrolysis, and there soon deposited upon the positive electrode a stratum of copper fluoride, a bad conductor that arrested the current. If the mixture of hydrofluoric acid and potassium fluoride be freed from water, the electrolysis will proceed very well with platinum electrodes in a copper vessel. This latter, under such circumstances, will not be attacked. It is probable that the fluorine that is soon found in solution in the hydrofluoric acid produces upon the surface of the copper a thin coat of that insulating fluoride (insoluble in hydrofluoric acid) of which we have already spoken.

The rendering of this new apparatus was established by measuring the volume of hydrogen disengaged at the negative pole within a determinate period of time. In a series of preliminary experiments, we assured ourselves that the volume of oxygen produced by the action of the fluorine upon the water well responded to the volume of hydrogen set at liberty at the positive pole, if account were taken of the quantity of ozone formed. With a current of 50 volts and 15 amperes, we obtained an hourly rendering of about 5 liters, when the experiment lasted from six to ten minutes. If we employ a current of 20 amperes at the same voltage, the rendering may amount to 8 liters; but in such a case the experiment could not last long, since the liquid becomes



MOISSAN'S COPPER APPARATUS FOR THE ELECTROLYTIC PREPARATION OF FLUORINE.

The figure to the right shows the details of a platinum electrode of wide surface.

too greatly heated, and, despite an energetic cooling of —50°, the fluorine gas carries along abundant vapors of hydrofluoric acid.

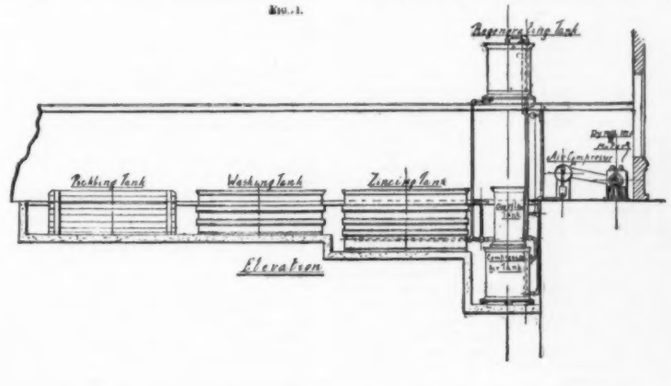
It is important also not to lower the temperature too much, else the combination of hydrofluoric acid and alkaline fluoride will set in a mass.

This new copper apparatus has given us very good results in some experiments that lasted for several hours, and has permitted us to enter upon a study of a few new questions that we shall soon discuss, and in which we have need of a continuous current of fluorine.—H. Moissan, in Revue Générale de Chimie Pure et Appliquée.

COWPER-COLES' REGENERATIVE ELECTRO-GALVANIZING PROCESS.

THE accompanying illustrations, Figs. 1 and 2, depict a plant which is in course of erection for the Imperial German Dockyard at Wilhelmshaven, also for the coating of boiler tubes of the Thornycroft type. The dynamo, which is capable of giving 2,000 amperes at six volts, is direct coupled to a three-phase motor, which is provided with a pulley for driving a small air compressor. The current is conveyed to the depositing tanks by means of bare copper strips. The circulation of the electrolyte is effected in the following manner. The acid solution falls over a wooden sill placed in one corner of the zincking tank (which is not, however, shown in the illustration) into the overflow tank; it then flows into the compressed air tank, when air is blown in and the solution forced up into the regenerating tanks. A non-return valve is placed in the pipe connecting the overflow tank to the compressed air tank. The supply of air to the compressed air tank is regulated by means of a three-way cock actuated by a float placed in the regenerating tank, in such a manner that when the air is cut off from the compressed air tank, it is blown through the solution in the zincking tank, thus keeping it agitated. The zinc dust is placed in the regenerating tanks on wooden grids covered with cocoa-nut matting; it is mixed with finely divided coke or sand. The regenerated electrolyte returns to the zincking tank at the bottom at the opposite corner to which it leaves.—Industries and Iron.

Fig. 1.



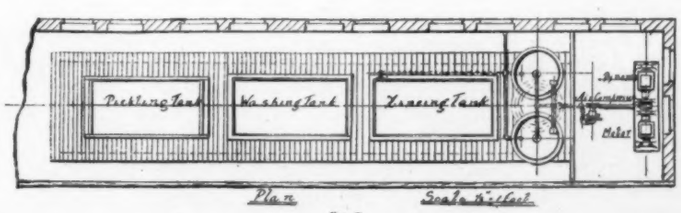


Fig. 2.

COWPER-COLES' ELECTRO-GALVANIZING PROCESS.

FORMALIN AS A PRESERVATIVE.

ALTHOUGH as a preservative medium for perishable zoological specimens formalin has scarcely realized all the expectations entertained on its introduction, yet there can be little doubt that it has a great future before it, and that for certain purposes it is likely to prove invaluable. It has, however, many undoubted disadvantages; and in the minds of some museum officials these disadvantages appear to outweigh its manifest valuable properties, so that an unfavorable opinion is entertained of it in general. On the other hand, those who weigh more carefully the pros and cons, realize that, under proper conditions and restrictions, its value is really very great.

As regards its disadvantages, it must be admitted that it is unsuitable for the permanent preservation of specimens that are likely to be manipulated, as not only are its effects on the hands of the worker most unpleasant, but in many cases it renders the tissues of the specimens themselves so hard that they are practically unworkable. Then, again, it is quite unsuited for all specimens containing calcareous matter, such as mollusks, echinoderms, and crustaceans; while unsatisfactory results appear to have been obtained in the case of certain insects and myriapods. Moreover, it does not seem to be well suited for the preservation of reptiles; and it is said to deteriorate the colors of bird skins.

Turning to its advantages as a permanent preserving fluid, it is acknowledged to be unrivaled for specimens of watery and "flabby" animals, such as jelly fish, rendering them more coherent and less likely to disintegrate than any other known medium. Apart from this group, it does not, however, appear to be at present used to any great extent in the exhibition series in the British Museum; although we have reason to believe that its possibilities are occupying the serious attention of the officials. In the series of worms, all the more valuable specimens that were received in formalin have been transferred to spirit, and only the commoner forms left in the original medium. Of the six specimens of eggs, embryos, and larvæ of Lepidosiren paradoxa recently added to the exhibition series from Mr. Graham Kerr's Paraguay collection, three are in alcohol and three in formalin; the latter having been sent home in that fluid, and it being thought not advisable that the medium should be changed. If these six specimens are carefully watched, they will afford a test-case of the comparative value of the media. At present, we believe, none of the exhibits in the "Index Museum" are in formalin.

For sterilizing freshly killed specimens of mammals and birds, as well as eggs, that have to be sent some distance to a museum in the flesh, there can be no doubt that formalin is invaluable. And it is no less valuable to the field collector of mammals, not only on account of the small bulk a sufficiency of the fluid occupies, but also from the marvelous preservative power of the fluid itself. According to Mr. O. Thomas (who reports very favorably of it for this purpose), commercial formalin, which is itself 40 per cent. underproof, must be diluted with no less than twenty-five times its own bulk of water before use. Moreover, whereas when mammals are preserved in spirit it is necessary to allow a very large amount of fluid to each specimen, when formalin is employed the vessels may be crammed as full as possible with specimens, which are preserved without exhibiting the slightest traces of putrefaction. When received at the British Museum, all such specimens are, however, immediately transferred to alcohol, on account of their unsuitability for handling when in the original medium.

The foregoing instances suffice to show that for certain specific purposes formalin has advantages as a preservative medium not shared by alcohol. But, as many of our readers are aware, another application of

formalin has been recently proposed by Dr. G. de Rechter, of the Brussels University, who, in the twelfth volume of the Annales de l'Institut Pasteur (1898), has advocated the use of currents of formalin vapor for the preservation of animal specimens. The advantages claimed for this method are that it preserves the specimens in practically the same condition as they were left at death; the tissues not being hardened, while hair and feathers are uninjured alike in texture and in color. Experiments in this method have been recently undertaken in Mauritius by Mr. Camille Sumeire, of the Albion Dock Company, who has constructed an apparatus on the general lines of one suggested by Dr. de Rechter, in which specimens can be subjected to constant currents of formalin vapor. And it appears from an illustrated report published in the Bulletin de la Société Médicale de l'Ile Maurice for July 18, that the results of these experiments have proved eminently satisfactory.

A freshly killed guinea-pig placed in the apparatus for a period of twenty days was found to be in a perfect state of preservation, and when exposed in the open in the museum for a further period of eight days, was likewise found to be intact. Moreover, a culture of bacilli exposed in the apparatus at the same time as the guinea pig was found to have become completely sterilized.

As was well remarked by Dr. de Grandprè, superintendent of the Port Louis Medical Museum, the potential advantages of such a method of preservation are likely to prove very important. And it is urged that the process may be specially valuable in cases of suspected poisoning, as bodies can be preserved for any length of time in a state suitable for examination. From a natural history point of view the invention has likewise almost unlimited possibilities; and Mr. Sumeire hopes to be able shortly to supply the museums of Europe with examples of the animals of Mauritius as fresh as when alive, instead of in the condition of ordinary spirit-specimens. Indeed, negotiations are already opened with the director of the Paris Museum for the transmission of such formalined specimens to the institution under his charge. We wish all success to the new venture.—R. L. in Nature.

THE COST OF WAR.

THE Washington Bureau of Ordnance recently issued some interesting statistics of the details of the cost of annihilating the Spanish navy. Admiral Dewey spent some $45,000 worth of ammunition in sending Montojo's fleet to the bottom of Manila Bay. In all, 5,681 projectiles were fired, for the most part six and one-pounders. The gallant Cervera's fleet, on that memorable morning in Santiago Harbor, was sunk, burned, or captured with an expenditure of $100,000. Seven thousand shells were fired, varying in size from 13-inch projectiles to one-pounders.

The Spanish-American war was certainly the cheapest on record, both in the waste of men and money.

The terrible civil war of 1861–65 cost the United States the tremendous figure of $3,700,000,000 and 656,000 men. There were 2,386,000 men in the Northern army, and of these but 44,240 were killed in actual combat, 183,036 dying from wounds and disease. The Southern army lost 26,730 killed and 200,000 in wounded and prisoners. For the conduct of that war the Ordnance Department of Washington served out 7,892 cannon, 4,022,000 rifles, 2,360,000 equipments, 12,000 tons of gunpowder, and 1,032,000,000 rounds of cartridges.

The American war of independence cost Great Britain $605,000,000, nearly double the amount expended on the Crimean war, which drew only $345,000,000 from the national exchequer. In the same war France spent $465,000,000, and Russia $710,000,000. Britain put 97,000 men into the field, of which 70,000 returned to England. France, as usual, was extravagant of her fighting men, and sent 309,408 to the Crimea to conquer their present ally. Of these, 95,000, nearly as many as the entire British force, lost their lives. To meet the armies of the allies, Russia put 888,000 men into the field, and half of these lie buried at Alma, Inkerman, Balaclava, and Sebastopol.

In less than three hundred years Great Britain has expended the respectable sum of £1,359,000,000 in war. The war with Germany and Spain in 1702, when Marlborough fought his "very murdering battles," cost the English £182,000,000. The war with France which culminated at Waterloo bled the British purse to the tune of £831,000,000, while the whole of the Napoleonic wars cost France only £355,000,000, though they had to fight the whole of Europe. It must be remembered, however, that England supplied large sums of money to many of the European powers in their struggles against the little emperor.

The last great European war, the Franco-Prussian, as may be expected, involved an enormous expenditure of life and money. Germany put 1,003,000 men into the field against a French force of 710,000. Of the French, 138,870 died in battle or in hospital, against 44,000 of the Germans. The latter fired off 30,000,000 musket cartridges and 363,000 rounds of artillery, with which they killed or mortally wounded 77,000 French, being 400 shots to kill one man. This war cost France $1,580,000,000.

Copals.—The copals are classed among the most important resins in the industries, two main groups, viz., "hard" and "soft" copals, being distinguished. Boiling water is poured over the copal to be tested, leaving it stand for about one-half hour in a covered vessel. Hard copal should remain absolutely unchanged by this process, while the "soft" article becomes cloudy and soft. Among the hard copals are Zanzibar copal, the best variety, and hard enough to be worked into trinkets on the lathe, Sierra Leone copal, Benguela copal, and Angola copal. Soft copals are Acera copal, Manila copal and Kauri copal, a commercial variety much in demand at the present time, which is dug in the forests of New Zealand, deriving from Daumara australis. The manufacture of the copal varnishes, the best varnishes known, is based upon the solubility of copals when molten in fat oils and varnishes. In melting, which is best conducted in a lead bath (324° C.), water, empyreumatic oil, and a non crystallizable pyro-acid escape, about 25 per cent. in all. In large factories, the empyreumatic oil is collected and used as a solvent for various gums.—A. Zucker in Pharmaceutische Zeitung.

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